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The Efficiency Measurement Using Data Envelopment Analysis Method: A Comparative Case Study between insurance companies CAAT and CAAR

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Abstract:
The purpose of this article is to provide facts on performance measurement in the Algerian insurance sector, through a DEA model to assess the efficiency in the CAAR and CAAT companies separately. To promote the ground for the empirical part of the analysis, which relates to a comparative case study, a BCC model was used to test CAAT and CAAR efficiency using a sample of 94 CAAT agencies and 90 CAAR agencies, while the agencies were used as DMUs in the VRS process, with an output-oriented DEA process. The key conclusions of this article are the dissimilarity between the two companies: volatility of revenue (premiums) over 2014, 2015, 2016, and productive agency rate, 65.5 percent for CAAT, 61.5 percent for CAAR.
Keywords: Algerian Insurance Companies, CAAR, CAAT, DEA Model, Efficiency.
Code classification JEL: H21, C44, G22.
Résumé :

L'objectif de cet article est de fournir des informations factuelles sur la mesure de la performance dans le secteur des assurances Algérien à travers un modèle DEA permettant d'évaluer séparément l'efficacité des Compagnies CAAR et CAAT. Afin de faciliter la mise au point de la partie empirique de l'étude qui concerne une étude de cas comparative, un modèle BCC a été utilisé pour

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évaluer l'efficience de la CAAT et de la CAAR en utilisant un échantillon de 94 agences de la compagnie CAAT et de 90 agences de la CAAR. Tandis que les agences ont été utilisées comme DMUs dans un modèle VRS, avec un modèle DEA orienté vers les résultats. Les principaux résultats de ce papier sont que la dissemblance enregistrée entre les deux compagnies correspond à la stabilité de la production (primes) pour les années 2014, 2015 et 2016, et que les pourcentages d'agences efficientes sont de 65,5% pour le CAAT et de 61,5% pour le CAAT.

Mots Clés: Compagnies d'Assurances Algériennes, CAAR, CAAT, Modèle DEA, Efficience.

Code de classification JEL : H21, C44, G22.

1- Introduction:

The financial institutions are the backbone of every country's economy. Whether in a developed or a developing country, the insurance sector plays a fundamental role in the functioning of the modern economy, by maintaining financial stability, moderate loss and by contributing to the country's GDP. This key sector has some specifications compared to other sectors' activities. Indeed, its production cycle is reversed, because of the interval existing between the claims occurrence and their settlement, and the difficulty to determine with exactitude the claims to pay.

The Algerian insurance sector is chartered with a competitive environment, since the insurance sector contains private, public or mixed companies such as the SAA, CAAT, CAAR, CASH and so many other companies. In such environment, insurance companies find themselves obliged to exercise their activities with efficiency to guarantee the stability and sustainability of their existence. To this end, insurance companies need a Performance Management System (PMS), which ameliorates their outcomes and their added value.

The performance of insurance companies has known a massive importance, in terms of preserving their competitiveness. In the last decade, several researches have been conducted to address the insurance companies' efficiency. The signification of this topic to the insurance companies is translated through its usefulness in providing information to support strategic decision undertaking, planning and control of the companies' objectives. Indeed, numerous efficiency measurement tools and methods in insurance companies have been developed in the literature, we can cite the Data Envelopment Analysis (DEA) for

performance measurement of Decision-Making Units (DMU) as the most appropriate method for measuring the efficiency.

Data Envelopment Analysis was developed by Charnes 1978 and extended by Benker et al 1984. DEA is a non-parametric linear programming method for the assessment of the efficiency and productivity of the Decision-Making Units, which allows the use of various inputs and outputs at the same time. DEA model has two orientations: an input-oriented model focusing on minimizing inputs and fixing the level of outputs; or an output-oriented model that concentrates on maximizing outputs with no changes in input values.

Research Problem:

Recently, insurance companies have known a great development, which made researchers more interested in studying its performance, efficiency and profitability. Yet, only few that made the Algerian insurance sector the pivot of their work. The aim of the present paper is to enrich the knowledge structure in this field. On this basis can be articulated problem research as follows: Can Data Envelopment Analysis model explain the differences in the efficiency of Algerian insurance companies CAAR and CAAT?

To provide answers, we verbalized the subsequent two (02) questions:

- Is the Variable Returns to Scale (VRS) model appropriate to measure the efficiency in Algerian insurance companies CAAR and CAAT?
- Does the performance assessment of Algerian insurance companies necessitate a model that evaluates technical and allocative efficiency?

The study hypotheses:

According to **Fareell,** the companies' efficiency could be measured using the estimation method of efficiency frontier, and the productive efficiency gathers both technical and allocative efficiency (De Cinzia Daraio, 2007). The researcher defined technique efficiency as the use of sources to make results but without wastage. Moreover, **Daniela Borodak** added that she divided the technical efficiency into pure technical efficiency, which is the capability of the company to maximize its outputs for a fixed amount of inputs and the efficiency scale which can be increased or decreased thus allowing the determination of the efficiency measure that permits the company's function (Boradak, 2007). Hence, it is fundamental to formulate our first hypothesis as follows: **H1.** The model that allows us to assess the performance of

insurance companies must be able to evaluate both technique and allocative efficiency.

Data Envelopment Analysis is a method that uses linear programming techniques to measure efficiency by taking into consideration several inputs-outputs. This model can be subdivided into input-oriented or output-oriented model as already explained in this paper. Also, another subdivision is possible in terms of returns to scale: Constant Returns to Scale (CRS) is the original subdivision by Charnes, Cooper and Rhodes, 1978. The main hypothesis in CRS is that all Decision-Making Units (DMUs) are operating at their optimal scale. The second subdivision is the Variable Returns to Scale (VRS). In this model, the efficiency is divided into technical and scale efficiencies (P.Andersen, 1993). This introduces our second hypothesis: **H2.** The appropriate DEA model to measure the efficiency in insurance companies is the Variable Returns to Scale (VRS).

The last hypothesis in this paper concerns the second part of the empirical case study which is dedicated to a comparative case study between two companies in the Algerian insurance sector, namely the CAAT (Algerian Company of Transport and Insurance) and the CAAR (Algerian Company of Insurance and Reinsurance). We see the third hypothesis as: **H3.** There are no differences between CAAR and CAAT, and both enjoy the same level of efficiency.

This research is structured as follows. First, we provide a description of the used Data and the research methodology. Second, we present the DEA model used in the empirical case study. Then, we furnish a comparative case study between the results of the two insurance companies. This is followed by the presentation of our empirical study's results, and an empirical analysis. The last section deals with the results discussion and the conclusion.

Importance of the study:

The study obtains its importance from the position of the theme itself. Both CAAR and CAAT are leaders in Algerian insurance sector, Therefore, our research paper intentions to understand the efficiency differences between the two companies using DEA model, and to aide the Algerian insurance companies for the importance of the efficiency measurement models, in order to improve their financial performance.

The Obective of the study:

The objective of this research is to provide knowledge about the measurement of performance in the Algerian insurance companies through the DEA model to measure, separately, the efficiency in each of the CAAR and CAAT, which paves the ground for the second part that

concerns a comparative case study between the studied companies. Therefore, by the end, we will be able to test the hypothesis of this study that is explained in the next subsection.

Literature review:

As shown above, DEA has been published since 1978, and the researches rolled in this road. Hereunder is a review of the literature of extensive researches, from more than a quarter of century to nowadays, where we tried to summarize the papers concerning the study of evaluating the efficiency of insurance companies using the DEA model. The presented literature review sample is generally composed of the world's most developed countries, which give an epitome to follow:

Facher.F et al., 1993., they studied efficiency measurements in 84 life and 243 non-life insurance companies of the French insurance sector using parametric and non-parametric approaches for the period 1984-1989. Both approaches lead approximately to the same findings: that the effect of the distribution ration is imprecise and that the claims ration is contradictory, positive for non-life and negative for life insurance. The main results demonstrate a high correlation between parametric and non-parametric indicators and a wide dispersion in the rates of inefficiency between companies, but this dispersion can be minimized through controlling variation in the scale, ownership, distribution, reinsurance and claims ratios. (Fecher, 1993)

Fukuyama 1997., the author studied Japanese life insurance companies, using panel data from the period 1988-1993 to investigate the productive efficiency and productivity changes with a non-parametric frontier framework. The results of this investigation are summarized as follows: during the expansion period, the relationship between investments and technological change are positive and significant, but in the recession period they are negatively and significantly related to congestion efficiency change. (Fukuyama, 1997)

Desheng Wu and al 2007., the study was made about the Canadian Life and Health (L&H) insurance companies in the period 1996-1998, using a new Data Envelopment Analysis (DEA) model. The model can assess the production and investment performance of insurers, it is a problem-oriented model based on the fact that the investment performance and the production are correlated, and it is different from classical DEA models that are appropriate for independent performance evaluation. The main outcome of this study is that the Canadian L&H insurance companies operate very efficiently and that no scale efficiency in the Canadian L&H insurance sector is found in this research. (Desheng Wu and al., 2007)

Lucinda Trigo-Gamarra and Christian Growitsch 2010., the study focused on the life insurance industry in Germany for the period 1997-2005, using non-parametric Data Envelopment Analysis to estimate the cost and efficiency for multichannel insurers, direct insurers, and independent agent insurers. The main findings in this study are the absence of performance advantage of specialized insurers and that distribution via multiple channels is superior to the specified distribution systems in the life insurance companies. (Growitsch, 2010)

David Cummins and Xiaoying Xie 2013., the authors examined the efficiency, productivity and scale economies in U.S.A property-liability insurance companies during the period 1993-2009, using Malmquist indices to analyse productivity change, and Data Envelopment Analysis as an efficiency measure. The results were categorized in three segments: first, the biggest part of companies below median size was functioning with augmenting returns to scale; second, the majority of companies above median size in this sector were operating with diminishing returns to scales and third, a significant part of both last segments achieved constant returns to scale. The study also revealed that more various companies and insurance groups were more likely to attain efficiency and productivity gains, which are positively related to higher technology investments. (Xie, 2013)

Nilüfer Dalkılıç and Ayşen Altun Ada 2014., the study focused on 20 Turkish life insurance and private pension companies using Data Envelopment Analysis and BCC (Banker, Cooper et Charnes) model, to analyse and to measure scale efficiency for the period 2010-2011. The findings of this study are summarized as follows: in 2011, there was an increase in the average scale efficiency of life insurance companies, and a decrease in the average for companies in private pension. The researchers concluded that 8 companies had to decrease inputs variables, but for the outputs, the results were different for each company. (Ada, 2014)

Taking into consideration the geometrical diversification and the different period phases, these studies did not register a contradiction between each other, nor between outcomes. Yet, there was a sort of complementarity and harmony in the findings of these researches. Through the aforementioned studies, we conclude the coherence and the effectiveness of Data Envelopment Analysis (DEA) in measuring insurance companies' performance, and that the DEA model can be reliable to give a real image about the performance in Algerian insurance companies.

2- Quantitative study:

2-1. Data collected:

According to National Insurance Council of Algeria, 93% of the Algerian insurance sector is non-life insurance segment; and among 24 insurance companies in Algeria, 13 operate on non-life segment, mainly lead by three public insurance companies, which are SAA (National Company for Insurance), CAAT (Algerian Company of Transport and Insurance) and CAAR (Algerian Company of Insurance and Reinsurance), with respective market shares of 21.2%, 16.1% and 12.8%, according to the 2014statistics. In this paper, we will study both CAAT and CAAR. (AssurAL, 2013)

As mentioned earlier in this paper, we will measure the performance for two of the top Algerian leaders in the insurance sector by using the DEA model. To set up this model, we need several inputs and outputs, and to determine the DMU from both companies, in our case, we will use the network agency for the 90 CAAR agencies as well as 94 CAAT agencies. These agencies are active and exist on the entire Algerian territory.

Our data were collected from the annual reports of the studied insurance companies over the 2014-2016 period, from which we defined our inputs as the average number of employees, operating expenses and the receivables, while our outputs are the premiums, compensations and the number of the cases (files) resolved. In this paper, we rely on a descriptive statistics method, a correlation analysis, Data Envelopment Analysis model and a comparative case study method.

2-2. DEA model:

There are two basic types of DEA models, one founded on the hypothesis of constant returns to scale, which is the CCR model; and the second is BCC based on the variability of returns to scale. This model is a quantity one, it is a linear programme that transfers multiple inputs into outputs, with subject analysis that the DMU efficiency score is equal to one (1) or 100%. In this subsection we will apply the DEA model on 90 CAAR agencies samples and 94 CAAT agencies samples. First, we will present study samples translated on the DMU (insurance agencies), then the chosen inputs and outputs. Finally, we formulate the optimization programmes.

The process explained above will allow us to apply the DEA method using the WINDEAP software. After that, we will analyse the obtained results.

In our attempt to define the chosen efficiency scale in this paper, which is the Variable Returns to Scale as the adequate scale to the Algerian insurance sector, the CRS is only appropriate or accepted if the DMUs are active in optimal conditions. This cannot be verified in the imperfect market competition.

The second part of the DEA model is the model orientation, even if the model orientation does not affect the study results if we were opting for CRS. However, it is opposed to the BCC model, and that the results would not be the same for the input-oriented or outputs-oriented models. Hence, it is fundamental to define the model's orientation, on adequacy with the objectives of agency managers, which is maximising the agency's premiums, leading us to adopt the output-oriented model that meets this target and is based on the goal of maximising the outputs for a fixed inputs level. (Grmanová E. &., 2017)

2-3. Comparative description of the CAAT and CAAR:

In this subsection, we will comparatively describe the companies studied, their market position through their production evolution in 2014, 2015 and 2016, as well as their portfolio structure so as to determine the main activities for each company, and at last, determine their compensation structure for 2016, the year of the study. The following table explains the production evolution for a given time interval:

Table N°1: Production Evolution from 2014-2016 in Million Algerian Dinars Unit

Production	2014	2015	2016
CAAT	20192	21160	22616
CAAR	16088	16637	15081

Source: Annual reports of CAAT and CAAR.

The production evolution of the CAAT Company registers 7% of annual increase between 2014, 2015 and 2016, where it reaches 22616 million Algerian Dinars in this year. On the other hand, for the CAAR Company, we notice an augmentation for both 2014 and 2015, but in 2016 it records a 9% decrease in the production evolution.The next table illustrates the portfolio structure:

Table N°2: Portfolio Structure of CAAT and CAAR in 2016

Portfolio Structure	Property and Casualty	Transport Insurance	Vehicle Insurance	Credit Insurance
CAAT	56%	9%	35%	0%
CAAR	49%	13%	38%	0%

Source: Annual reports of CAAT and CAAR.

The portfolio structure for both the companies is pretty much similar, where P&C is the main insurance activity with 56% for CAAT and 49% for CAAR. The second largest activity is vehicle insurance, with 35% and 38% for the CAAT and the CAAR, respectively. The third activity is the transport insurance, and we notice a total absence of the credit

insurance for both companies. The following table explains the compensation structure in the companies studied:

Table N°3: Compensations Structure of CAAT and CAAR n 2016

Compensations structure	Property and Casualty	Transport Insurance	Vehicle Insurance	Credit Insurance
CAAT	49%	3%	48%	0%
CAAR	44%	11%	45%	0%

Source: Annual reports of CAAT and CAAR.

The distribution of compensations over the companies' activities is similar to the contribution of each activity in the companies' portfolio structure, where the compensations are higher in P&C, vehicle insurance, and transport insurance than credit insurance, respectively.

1.1.Inputs / Outputs determination and DEA model set up:

One of the prerequisites of using DEA model is that the outputs observations should be superior or equal to the observations of the inputs. Therefore, in this paper, we took three inputs for three outputs and the inputs and outputs measurements used were monetary and physical units. The following table below presents the variables used in this study:

Table N°4: DEA Model Inputs/ Outputs and Abbreviations

Variable	Input/ output	Abbreviations
Average Number of Employees	Input	ANE
Operating Expenses	Input	OE
Receivables	Input	RCV
Premiums	Output	PRM
Compensations	Output	CMP
Number of the Cases (files) Resolved	Output	NCR

Source: Made by ourselves.

We have: $i\epsilon(1,\cdots,94)$; $j\epsilon(1,\cdots,94)$ and $r\epsilon(1,\cdots,94)$ …. CAAT

$i\epsilon(1,\cdots,90)$; $j\epsilon(1,\cdots,90)$ and $r\epsilon(1,\cdots,90)$……CAAR

$$X=\begin{pmatrix} ANE \\ OE \\ RCV \end{pmatrix} \quad , \quad Y=\begin{pmatrix} PRM \\ CMP \\ NCR \end{pmatrix}$$

X : Inputs. Y : Outputs.

So the BCC model is presented as follows for both CAAT and CAAR:

CAAT: n= 94 CAAR: n=90

$$\begin{cases} Max\theta_i - \varepsilon(\sum_{i=1}^{94} s_i^- + \sum_{r=1}^{94} s_r^+ \\ \sum_{j=1}^{94} \lambda_j ANE_J + s_i^- = \theta ANE_i \\ \sum_{j=1}^{94} \lambda_j OE_J + s_i^- = \theta OE_i \\ \sum_{j=1}^{94} \lambda_j RCV_J + s_i^- = \theta RCV_i \\ \sum_{j=1}^{95} \lambda_j PRM_J - s_i^+ = \theta PRM_i \\ \sum_{j=1}^{94} \lambda_j CMP_J - s_i^+ = \theta CMP_i \\ \sum_{j=1}^{94} \lambda_j NCR_J - s_i^+ = \theta NCR_i \\ \sum_{j=1}^{94} \lambda_j = 1 \\ \lambda_j > 0\ ;\ s_i^-, s_i^+ \geq 0 \end{cases} \quad \begin{cases} Max\theta_i - \varepsilon(\sum_{i=1}^{90} s_i^- + \sum_{r=1}^{90} s_r^+ \\ \sum_{j=1}^{90} \lambda_j ANE_J + s_i^- = \theta ANE_i \\ \sum_{j=1}^{90} \lambda_j OE_J + s_i^- = \theta OE_i \\ \sum_{j=1}^{90} \lambda_j RCV_J + s_i^- = \theta RCV_i \\ \sum_{j=1}^{90} \lambda_j PRM_J - s_i^+ = \theta PRM_i \\ \sum_{j=1}^{90} \lambda_j CMP_J - s_i^+ = \theta CMP_i \\ \sum_{j=1}^{90} \lambda_j NCR_J - s_i^+ = \theta NCR_i \\ \sum_{j=1}^{90} \lambda_j = 1 \\ \lambda_j > 0\ ;\ s_i^-, s_i^+ \geq 0 \end{cases}$$

3- The study results:

We applied the DEA model using DEAP version 2.1[1]. And we obtained the next results:

Table N°5: Model results

Agency DMUs	CRS	VRS	scales	RE	Agency DMUs	CRS	VRS	scales	RE
A-101	0.785	0.862	0.911	Drs	**B-203**	0.367	0.452	0.812	Drs
A-102	0.426	0.479	0.889	Drs	**B-205**	0.383	0.635	0.603	Drs
A-103	0.127	0.183	0.696	Drs	**B-206**	0.786	0.802	0.980	Irs
A-104	0.251	0.372	0.675	Drs	**B-208**	0.447	0.485	0.922	Irs
A-105	0.710	0.842	0.844	Drs	**B-210**	1.000	1.000	1.000	-
A-107	0.539	0.618	0.873	Irs	**B-212**	0.468	0.576	0.813	Drs
A-108	0.377	0.395	0.956	Irs	**B-213**	1.000	1.000	1.000	-
A-109	0.435	0.497	0.874	Drs	**B-214**	0.274	0.277	0.990	Drs
A-141	0.730	0.854	0.854	Drs	**B-215**	0.414	0.420	0.986	Irs
A-142	0.306	0.559	0.548	Drs	**B-216**	0.430	0.430	1.000	-
A-143	0.452	0.520	0.870	Drs	**B-219**	1.000	1.000	1.000	-
A-144	0.474	0.479	0.989	Drs	**B-223**	0.273	0.359	0.761	Drs
A-145	0.701	0.842	0.832	Drs	**B-226**	0.924	1.000	0.924	Drs
A-146	0.794	0.853	0.931	Drs	**B-228**	0.572	0.617	0.927	Irs
A-147	0.889	1.000	0.889	Drs	**B-229**	0.870	1.000	0.870	Drs
A-148	0.527	0.641	0.822	Drs	**B-230**	0.892	0.906	0.985	Drs
A-149	0.596	0.695	0.857	Drs	**B-231**	0.666	0.686	0.971	Drs
A-150	0.513	0.748	0.685	Drs	**B-232**	0.624	0.701	0.891	Irs
A-151	0.558	0.695	0.803	Drs	**B-233**	0.470	0.569	0.827	Drs
A-152	0.564	1.000	0.564	Irs	**B-234**	1.000	1.000	1.000	-
A-153	0.566	0.847	0.668	Drs	**B-301**	0.458	0.465	0.986	Drs
A-181	1.000	1.000	1.000	-	**B-302**	0.308	0.396	0.777	Drs

[1] http://www.uq.edu.au.

A-182	0.268	0.529	0.507	Drs	**B-303**	0.389	0.404	0.962	Irs
A-183	0.206	0.330	0.623	Drs	**B-304**	1.000	1.000	1.000	-
A-184	1.000	1.000	1.000	-	**B-306**	0.374	1.000	0.374	Irs
A-185	0.474	0.714	0.663	Drs	**B-307**	0.725	0.863	0.840	Drs
A-186	0.432	0.438	0.986	Irs	**B-308**	0.715	0.799	0.895	Irs
A-187	0.344	0.380	0.905	Drs	**B-309**	1.000	1.000	1.000	-
A-188	0.563	0.692	0.814	Drs	**B-310**	0.217	0.218	0.999	-
A-189	0.300	0.366	0.819	Drs	**B-311**	0.397	0.397	1.000	-
A-190	0.622	0.642	0.970	Drs	**B-312**	0.211	0.540	0.391	Irs
A-191	0.489	0.778	0.628	Drs	**B-313**	0.500	0.556	0.900	Drs
A-192	0.318	0.356	0.893	Drs	**B-314**	1.000	1.000	1.000	-
A-193	0.702	1.000	0.702	Irs	**B-315**	0.388	0.406	0.956	Drs
A-194	1.000	1.000	1.000	-	**B-316**	0.588	0.614	0.958	Drs
A-195	0.799	0.799	1.000	-	**B-317**	1.000	1.000	1.000	-
A-196	0.717	0.830	0.864	Drs	**B-318**	0.548	0.796	0.688	Irs
A-221	0.961	1.000	0.961	Drs	**B-319**	0.523	0.548	0.955	Irs
A-222	1.000	1.000	1.000	-	**B-320**	0.655	0.747	0.878	Irs
A-223	0.380	0.543	0.700	Drs	**B-321**	0.320	0.378	0.845	Drs
A-224	0.569	0.758	0.750	Drs	**B-322**	0.928	0.928	1.000	-
A-225	0.570	0.787	0.724	Drs	**B-323**	0.323	0.510	0.633	Drs
A-226	0.483	1.000	0.483	Drs	**B-401**	0.300	0.458	0.655	Drs
A-227	0.772	0.863	0.896	Irs	**B-402**	0.557	0.801	0.696	Irs
A-228	0.383	0.387	0.991	Irs	**B-403**	0.280	0.311	0.899	Drs
A-229	0.335	0.342	0.979	Drs	**B-404**	0.270	0.273	0.990	Drs
A-230	0.638	0.830	0.769	Drs	**B-405**	0.481	0.488	0.986	Drs
A-231	0.585	0.597	0.980	Drs	**B-406**	0.290	0.303	0.955	Irs
A-232	0.865	1.000	0.865	Drs	**B-407**	0.148	0.251	0.589	Irs
A-233	1.000	1.000	1.000	-	**B-408**	0.418	0.437	0.957	Irs
A-234	0.756	0.783	0.965	Drs	**B-409**	0.283	0.350	0.808	Drs
A-235	0.455	0.565	0.806	Drs	**B-411**	0.169	0.178	0.950	Drs
A-236	0.247	0.265	0.933	Irs	**B-412**	0.939	0.974	0.965	Drs
A-237	0.516	1.000	0.516	Irs	**B-413**	0.962	1.000	0.962	Drs
A-238	0.391	0.449	0.872	Drs	**B-414**	0.283	0.284	0.996	Drs
A-240	0.316	0.428	0.738	Drs	**B-415**	0.282	0.299	0.945	Drs
A-261	0.427	0.562	0.759	Drs	**B-416**	0.626	0.663	0.945	Drs
A-262	0.398	0.707	0.562	Drs	**B-417**	0.565	0.800	0.706	Drs
A-263	1.000	1.000	1.000	-	**B-418**	0.540	0.553	0.976	Drs
A-264	1.000	1.000	1.000	-	**B-419**	0.410	0.455	0.901	Drs
A-265	0.557	0.875	0.637	Drs	**B-502**	0.502	0.505	0.993	Irs
A-266	0.791	0.961	0.823	Drs	**B-503**	0.501	0.501	1.000	-
A-267	0.305	0.358	0.850	Drs	**B-504**	0.487	0.494	0.985	Irs
A-268	0.736	0.736	1.000	-	**B-505**	0.245	0.256	0.959	Irs
A-269	0.462	0.474	0.975	Irs	**B-506**	0.620	0.625	0.993	Drs

A-270	0.276	0.324	0.853	Drs	**B-507**	0.334	0.339	0.986	Irs
A-271	0.401	0.427	0.939	Drs	**B-508**	0.487	0.532	0.915	Irs
A-301	0.664	0.761	0.872	Drs	**B-509**	0.564	0.566	0.997	Irs
A-302	0.798	0.821	0.972	Drs	**B-510**	0.636	0.650	0.978	Irs
A-303	0.533	0.894	0.596	Drs	**B-511**	1.000	1.000	1.000	-
A-304	0.663	1.000	0.663	Drs	**B-512**	0.213	0.217	0.986	Irs
A-305	0.646	0.752	0.859	Drs	**B-514**	0.303	0.303	0.999	-
A-306	0.566	0.674	0.839	Drs	**B-515**	0.181	0.407	0.446	Irs
A-307	0.793	0.798	0.994	Irs	**B-601**	1.000	1.000	1.000	-
A-308	0.212	0.268	0.793	Drs	**B-602**	1.000	1.000	1.000	-
A-309	0.547	0.778	0.703	Drs	**B-604**	0.366	0.432	0.849	Drs
A-310	0.384	0.389	0.986	Drs	**B-607**	0.427	0.431	0.991	Drs
A-311	0.642	0.689	0.931	Drs	**B-609**	1.000	1.000	1.000	-
A-312	0.450	0.516	0.872	Drs	**B-611**	0.838	0.915	0.916	Drs
A-313	0.436	0.492	0.886	Drs	**B-620**	0.450	0.509	0.884	Drs
A-314	0.543	0.630	0.862	Drs	**B-621**	0.503	0.553	0.909	Drs
A-315	0.982	0.982	1.000	-	**B-622**	0.536	0.574	0.935	Drs
A-341	0.547	0.644	0.848	Drs	**B-625**	0.470	0.478	0.982	Drs
A-342	0.331	0.551	0.600	Drs	**B--627**	0.252	0.274	0.921	Drs
A-343	0.344	0.367	0.939	Drs	**B-629**	0.320	0.325	0.983	Drs
A-344	0.396	0.586	0.676	Drs	**B-630**	1.000	1.000	1.000	-
A-345	0.535	0.606	0.882	Drs	**B-631**	0.274	0.541	0.506	Irs
A-346	0.372	0.383	0.970	Drs	**B-632**	0.576	0.656	0.877	Drs
A-347	0.309	0.415	0.745	Drs	**B-633**	0.548	0.550	0.997	Irs
A-348	0.377	0.485	0.777	Drs	**B-634**	1.000	1.000	1.000	-
A-349	0.258	0.337	0.768	Drs					
A-350	0.274	0.296	0.927	Drs					
A-352	0.271	0.303	0.893	Drs					
A-353	0.282	0.295	0.953	Drs					

Source: Based on the results of the statistical analysis.

In the previous table, each of A-XXX and B-YYY is a codification of the agencies or the DMUs studied, where A refers to CAAT agencies and B for CAAR agencies. The second column in the table presents the results of the constant returns to scale in the CRS model, while the third column represents the of variable returns findings to scale in the VRS model. The scale is the ratio of CRS/VRS. The last column belongs to the returns to scale Increase Irs or Decrease Drs for each agency.

3-1. DEA results analysis

We can summarize the DEA model results in the following table by presenting the percentage of efficient and inefficient agencies from the two companies:

Table N°6: DEA results in CAAT and CAAR

Efficiency/ DEA results	CAAT	CAAR
Efficient agencies	16%	20%
Inefficient agencies	84%	80%
Total	100%	100%
Average Score of efficiency	65.5%	61%

Source: Based on the results of the statistical analysis.

BCC was the model used in this study and its results were explained in the previous table. Indeed, from the sample studied for each insurance company, we found 15 CAAT agencies and 18 CAAR agencies representing 16% and 20% respectively; these agencies represent the technical efficiency in this model, and consequently they constitute the efficiency frontier for the agency network. Such agencies are also named the **Peers** or the **benchmarks**. On the other hand, we found that the average score of efficiency reached 65.5% for CAAT and 61% for CAAR. After analysing the services provided to private and professional clientele, we observed the performance in the quality of services provided: the majority of the agencies have an efficiency score higher than 50%, and the minority of agencies provide an efficiency score lower than 50%.

3-2. Returns to scale effect

The VRS score represents the performance in resource management, but the CRS represents the global technical performance, and as explained above the efficiency scale is the ratio between CRS/VRS: $\text{Efficiency scale} = \frac{\text{Score CRS}}{\text{Score VRS}}$

Our analysis of the efficiency scale is explained in the following table:

Table N°7: Number of Efficient Agencies According to CRS and VRS

BBC model	CAAT	CCAR
Efficient agencies according to CRS	7	14
Efficient agencies according to VRS	15	18

Source: Based on the results of the statistical analysis.

Firstly, we would like to analyse the CAAT agencies, with 8 efficient agencies according to the VRS model results, but inefficient according to CRS. These agencies are: A-147, A-193, A-221, A-226, A-232, A-237 and A-304, for the CAAR agencies. Four agencies have similar results of being efficient in VRS and inefficient in CRS, which are: B-226, B-229, B-306, and B-41. This inefficiency scale is caused by the increase or decrease in the return on scale.

3-3. The Benchmarks agencies

The benchmarks agencies represent a reference to the inefficient ones determined by the VRS model; these technically inefficient agencies should be compared to the efficient group, to simulate their management and inputs/outputs combination. They provide insightful information for the agencies managers in a term to ameliorate their agencies' performance and efficiency. The following table presents the obtained results of each benchmark number of occurrences:

Table N°8: The Occurrence of Benchmarks

CAAT	**Agency**	**A-147**	**A-181**	**A-184**	**A-193**	**A-194**	**A-232**	**A-233**	**A-263**	**A-264**	**A-304**			
	Occurrence	**40**	**36**	17	7	**72**	28	2	**44**	19	**36**			
CAAR	**Agency**	**B-210**	**B-219**	**B-226**	**B-304**	**B-306**	**B-309**	**B-314**	**B-317**	**B-413**	**B-511**	**B-602**	**B-609**	**B-630**	**B-634**
	Occurrence	**28**	**27**	1	**66**	3	17	**21**	17	10	**20**	11	7	3	16

Source: Based on the results of the statistical analysis.

For the CAAT Company, we notice the following agencies to have the highest number of occurrences in the VRS model results: **A-147**, **A-181**, **A-194**, **A-263**, **A-263** and **A-304,** which represent the benchmarks. With reference to the majority of the CAAT network agencies, because of their high performance level, the other agencies should stimulate their inputs/outputs combination. The CAAR results are little but dissimilar, because the concentration of the occurrence in **B-304** as the benchmark is higher than in **B-210** with half the number of occurrences. Hence, these two agencies represent the reference for the CAAR network agencies.

On the other hand, the DEA results are influenced by the inputs and outputs samples chosen. As a matter of fact, the number of efficient agencies increases if the number of the variables increases. It is more pertinent that DEA model requires anequilibrium between the DMUs, the inputs/outputs used, and that smaller samples make the method lose its power of discrimination between each of the DMUs, that is why we

tried to apply the DEA model to a sample whose number exceeds twice or more the inputs and outputs used[2].

4- Conclusion:

The first hypothesis in this paper concerned the appropriate model that allows us to evaluate the insurance companies' performance. So, after examining the literature review and the previous studies in this field, we found that DEA has a quite good reputation in achieving the researchers' goals of assessing the insurance companies' efficiency.

Additionally, confirming our second hypothesis, we see that VRS is more appropriate for the insurance companies' environment than CRS, where the insurance market is everything but an optimal environment. When it comes to the model-orientation, we had chosen the outputs-oriented model that we judge more suitable to our DMUs (agency) manager's objective, which is to maximize the outputs by fixing the number of inputs allocated.

The main hypothesis in this paper is dedicated to analysing the efficiency dissimilarity between the two companies of the study (CAAR and CAAT). To test the eligibility that both CAAT and CAAR have the same level of efficiency, we started with a descriptive comparison of the companies' production, portfolio, and compensation structure. We reached the outcome that the portfolio and compensation structure have pretty much the same structure, where the main activity for both companies is P&C rather than vehicle insurance. On the other hand, production in CAAT Company is more stable, while in 2016 the CAAR Company recorded negative fluctuation in the same section. This descriptive analysis helped us to pave the ground for the DEA model. We opted for the same inputs/outputs variables and the VRS model with output-oriented model, so that we would be able to compare the results that illustrate that the CAAT Company had an average efficiency score equal to 65.5% while the CAAR Company had 61%; but the percentage of efficient DMUs is 20% for CAAR and 16% for CAAT. Hence the number of network agencies is not the same in the companies studied. For a better understanding of the DEA model results, we had studied the effect of efficiency scale and identified the benchmarks agencies for each agency network.

[2] Cooper et al. (2006, p. 106) « if the number of DMUs (n) is less than the combined number of inputs and outputs (m + s), a large portion of the DMUs will be identified as efficient and efficiency discrimination among DMU is questionable due to an inadequate number of degrees of freedom. (…). Hence, it is desirable that n exceeds m + s by several times. A rough rule of numbs in the envelopment model is to choose n (= the number of DMUs) equal to or greater than max {m xs, 3 x (m + s)}. »

After the application of the DEA model, now we are capable of classifying the network agency for each company studied, because of its efficiency score. Furthermore, we identified the benchmarks agencies, we tried to compensate for the lack of data for each agency's environment and its geographical existence (Wilaya), because we see for example that an agency operating in Ghardia does not have the same environment as another situated in Didouche Mourad in Algiers. Therefore, we suggest that further researches include the DMUs environment in the DEA model variables, since the possible results may be important for the management of insurance companies in the Algerian sector and are likely to improve their position in the Algerian economy.

Recommendations:

- Integrate the DEA method into the CAAT and CAAR performance measurement system;
- Use DEA efficiency scores as signs, which indicate agencies that require individual and pertinent analysis;
- Use the results obtained to identify Benchmarks agencies, and ensure apply their methods to the other agencies, in a scrutinize manner;
- Develop analytical accounting so the companies would be able to determine their accurate costs, as well as inputs and outputs;
- The study supplied the information concerns the global image of the DMUs situation (agencies network), and efficiency assessment synthesis, which clarify a needed optimization of the management control department in both CAAT and CAAR.

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