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Technical Efficiency of Health in Tunisia: Analyse with Data Envelopment Analysis Method

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Abstract

This study evaluates the technical efficiency of Tunisia's health system over the period 1990–2022 and identifies the structural determinants that shape it. Existing assessments of Tunisian health performance rarely span the pre- and post-revolution periods within a single analytical framework, leaving policymakers without a longitudinal view of how systemic shocks reshaped efficiency. To address this gap, the studies apply a two-stage approach: Data Envelopment Analysis (DEA) under variable returns to scale (BCC model) to compute annual efficiency scores, followed by a Tobit regression to explain variation in those scores. The DEA specification uses three inputs (hospital beds per 1,000 people, number of inhabitants per doctor, and current health expenditure per capita in PPP) and two outputs (healthy life expectancy at birth and survival to age 65). Efficiency scores were computed with DEAP 2.1. The results reveal three distinct phases. During 1990–1999, efficiency scores remained above 0.7 in most years, reflecting a health system considered among the strongest in Africa. The 2000–2010 phase sustained high performance, with scores clustered near unity and reaching full efficiency in 2003. From 2011 onward, however, scores declined steadily from 0.829 to 0.601 in 2022, driven by post-revolution economic deterioration, brain drain among physicians, and weakening public investment. The Tobit estimation shows that the number of hospital beds is positively and significantly associated with efficiency, while poverty and population density exert significant negative effects. These findings suggest that expanding hospital capacity while addressing poverty and demographic pressure offers a viable path to restoring efficiency.

Keywords: health systems, efficiencies, economic, methodology, DEA

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1. Introduction

Health appears in the world as one of the main criteria which determines the level of development of the countries thus to revive the economic, social and cultural activities for the countries. Health systems play a crucial role in determining the health status of the population through the results achieved by the systems in question. Improving the health status of the population is the main objective of the health system. Indeed, it is health that broadens the technical potential of any kind and appears as a fundamental requirement for society. Therefore, any health organization, especially the hospital, must define the main fundamental options aimed at its optimal integration into the economic, health and social environment. These great options must ensure its survival, development, and ability to grow. To be effective, the health system must clearly define its objectives, these objectives result:

- From the definition in the broadest sense of its field of activity (care, teaching, research, prevention).
- Of its role and social responsibility. The hospital must make the best use of the resources available to it in the interest of the community and not for its satisfaction.
- From the values and aspirations of its leaders, at this level, the specificity of the health system appears insofar as it includes a multiplicity of leaders: boards of directors, directors, doctors, etc.

The analysis of the performance of the health system has received particular attention in recent decades; indeed there are several theoretical as well as empirical works whose objective is to study health efficiency and to propose the possible solutions to increase the performance of this sector. Today, performance is a primary objective for any

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business, administration or organization. This concept means an efficient allocation of available resources taking into account the constraints imposed by the production technology, the structure of the market and the objectives set by the entrepreneurs. The assessment of efficiency has given rise to the concept of efficiency, which can be defined as the ratio between the results achieved by a production system and the objectives pursued. The first work on the concept of efficiency was done by Farell (1957) who clearly defined the concept of economic efficiency; he was the first to distinguish between the concepts of technical efficiency and allocative efficiency.

Measuring the performance of the health system, therefore, appears to be a problem of great importance. The DEA method provides the methodological framework needed to solve such a problem. Empirically, the DEA method has been widely used to measure the efficiency of production units in various sectors of activity, particularly in the transport sector Tang, T (2023), in the energy sector Zhi, Q (2023) in the agricultural sector, in the health sector Er Rays, Y and al. (2021), etc.

Our work is in this context and in which, the studies will explore the measure of efficiency of the health system in Tunisia for the period between 1990 and 2018, thus to study the impact of health indicators on health performance. In this context the studies search to answer the following questions: How is the DEA method of assessing the efficiency of the health system? What are the reforms to be proposed to improve the health system in Tunisia? And what is the impact of health indicators on efficiency?

The paper is organized as follows: the studies start with literature review. The definition of the performance and efficiency of a production unit and the approaches used to evaluate these two notions will present in section 2. Then, the studies discuss the modeling framework and the different basic models of the DEA methodology in section 3. The empirical application of the DEA methodology will be the subject of our empirical study so the studies will apply this methodology to the health system in Tunisia for the period between 1990 and 2018 to measure technical efficiency will be discussed in the next section. Then, the statistical procedures to test for differences in efficiency are discussed and followed by the presentation and discussion of the empirical results. Finally, in conclusion, the possible extensions and limitations of the present study are presented.

2. Literature Review

The health system in the world knew a revolution towards more efficiency at the level of the services given as well as in the investment in the health infrastructure in addition to the international efforts to support the health sector in the world to improve the performance and the services provided to patients. This idea constitutes the main question of several theoretical as well as empirical works to evaluate the efficiency of the sanitary system.

Empirically, Er Rays, Y and al. (2024) studied the technical efficiency of 77 public hospital networks in Morocco from 2017 to 2020. Using the Data Envelopment Analysis (DEA) method and, the Malmquist index. This study was based on three inputs (Hospital, Physician and Paramedical) and four outputs (Functional capacity, Hospitalization days and Admission). Results suggest that value of the average technical efficiency indicate that these networks need to minimize their inputs by approximately 30.3%.

Schuknecht, A. and al. (2006) analyze the effectiveness of the public sector of new members in the European Union concerning the emerging country in terms of the impact of public spending; this study proves that the efficiency of spending, in particular, differs from the group of emerging countries with the best performance in Asia. The empirical investigation shows that higher incomes, higher skill levels and education in the public system in addition to the security of property rights appear to facilitate the prevention of inefficiencies in the public sector.

Using the DEA approach and the Tobit model, Samut P, K. and al. (2016), studied the efficiency of hospitals in 26 OECD member countries for the period 2000 and 2010 and the determinants affecting hospital activities. In the first part, the authors examined the efficiency of hospitals using the DEA methodology to calculate the efficiency scores. They found that efficiency scores obtained after 2000 tended to fall in 2004 and reached the minimum level between 2009 and 2010. In the second part, they examined the effect of economic indicators on technical performance computed from the DEA methodology while using the Tobit model. Empirical results show that the environmental factors that positively affect the efficiency of hospitals are income, education and the number of private hospitals, while the effects of public and private health expenditure and the number of public hospitals adversely affect the performance of the health system.

Spinks, J. and al. (2005), they proposed that comparisons of the effectiveness of the public health system between a group of OECD countries using data from the WTO and the OECD are useful for informing public authorities about the level of health system efficiency. In their countries, these results are given from the DEA methodology.

In theory, such an analysis uses measures of socio-economic determinants of health applicable to all social policies, not just health policies. This study assesses health effectiveness in OECD countries using DEA-based Malmquist indices. They find an average value of 0.961 for an OECD dataset suggesting that member countries have moved slightly away from the efficient frontier, implying a decline in technical efficiency for the period between 1995 and 2000.

Vitezić, N. and al. (2019) explored the analysis of performance in public health services in Croatia in 2017. The results prove that the health system in Croatia and ineffective to the extent that efficiency is low and inadequate. To improve the measurement of public health effectiveness the authors have developed an integrative conceptual model DEABSC which has been tested at the Institute of Public Health Education – the Department of Health Ecology. The aim of combining DEA and BSC is to improve the efficiency of public health service programs. The study confirms that it is possible to determine the relative effectiveness of different DMUs within the health ecology department and to use best practices for each perspective in the BSC Cause & Effect conceptual model.

To assess the efficiency of public health systems in Europe using a non-parametric method such as the DEA methodology, Asandului, and al. (2014) explored the effectiveness of European public health care systems for 30 European countries for the year 2010. The authors concluded that developed countries invest in the health care system more effectively which makes it more efficient and is located on the frontier deficiency the studies find Romania and Bulgaria are good examples. Romania, despite having the highest rate in terms of the number of doctors in relation to the number of the population, also has the highest rate in terms of infant mortality in Europe. In this context, the studies also find the existence of the more developed countries and which have the highest GDP but they are, there are also more developed countries that are technically inefficient. The authors show that effectiveness also depends on good governance of the health system. It is a series of organizational regulations that can improve the efficiency and effectiveness of the health system and, consequently, on the quality of health services.

3. Methodology

3.1. Socio-Economic Determinants of Health in Tunisia

3.1.1. Health in Tunisia

The Tunisian government has invested in the health sector by building a hospital infrastructure that is both public and private which has made it possible to extend health coverage to all regions of the country. The Ministry of Public Health controls the population for the purpose to allow the harmonious development of its physical and mental faculties and its adaptation to the natural and the social environment of the country by the fight against the causes of deterioration of the physical or mental well-being that can affect it individually or collectively.

Health efforts have contributed to improving health indicators:

- Life expectancy increased from 68.3 years in 1987 to 76.1 years in 2018.
- Infant mortality fell from 43.3 per 1,000 births in 1990 to 14.6 per 1,000 in 2008.
- The medical coverage rate increased from 1 doctor for 2384 inhabitants in 1987 to 1 doctor for 728 inhabitants in 2018.
- The vaccination coverage rate against the six diseases covered by the global vaccine program has reached more than 96% of children up to the age of 1 year.
- The density of basic health centers reached 1/3826 inhabitants in 2018 against 1/5350 at the beginning of 1993.
- The percentage of gross domestic product allocated to the health sector is 3.9% in 2016.

3.1.2. Demographic Evolution

The Tunisian population has increased from 3.8 million in 1956 to 8.8 million in 1994 and 11.8 million in 2019. Tunisia has been able, with a forward-thinking family planning policy, to reduce the natural growth rate. This rate, which was in the order of 2.58% in 1984, was reduced to 1.1% in the first semester of 2019.

3.1.3. Public Health Infrastructure

The public sector remains the main provider of particularly preventive and hospitable health care. It is based on three levels of hospital service:

- The first level consists of 2157 basic health care centers and 108 district hospitals in the year 2017.
- The second level is covered by 31 regional hospitals most often located at the center of each governorate in the year 2017.
- The third level is marked by the construction of 22 university hospitals, totaling 196 departments with 40 specialties in the year 2017.

Besides this public infrastructure, there is a Para-public infrastructure:

- It is a 6 polyclinic of the National Social Security Fund (CNSS), which provides general outpatient care, specialized care, and diagnostic services to social affiliates.

3.1.4. Private Health Infrastructure

It consists of an ambulatory network of general or specialized medicine, paramedical care, and hospitalization structure. This infrastructure is composed of:

- 98 private clinics in the year 2018 with a multidisciplinary or mono-disciplinary.
- 4087 dental medicines.
- Capacity of 30680 in the year 2019 beds against 5603 beds in the private sector.
- 6702 private medical practices including 50.9% of specialists.
- 6900 pharmacies: 56% of women and 44% men.
- 107 radiologists free practice.
- 486 Medical Analysis Laboratories: 433 Medical Biology Laboratories and 53 Biology Anatomy Laboratories.
- 117 hemodialysis centers containing 2280 machines.
- 4592 paramedical practice for free practice.

(Source: Ministry of Public Health of Tunisia)

Public Hospitals that do not report to the Ministry of Public Health:

- 3 Military Hospitals.
- 1 Hospital of Internal Security Forces in Tunisia.

(Source: National Statistical Institute)

3.1.5. Factors Influencing Health

Thus, and based on the definition of WHO constitution, health is not only the absence of disease and infirmity but a complete state of physical, mental and social well being, the mission of health workers must, beyond their traditional functions (fight disease and death) take charge of promoting the health of the individual, families, and communities.

Health should no longer be defined concerning to the disease but about to the harmonious development of the personality of each one, considered in all its complexity and all these aspects, biological, psychological and social, none of which should be neglected with others. Health is, also, the ability of man to adapt to a constantly changing of the environment: continuous adaptation to the microbial, physical, chemical and mental stresses that man faces every day.

Of the factors that influence human health, six play a major role:

- Biological and health factors.
- Geographical factors.
- Demographic factors.
- Psycho-cultural factors.
- Socio-economic factors.
- Political factors.

Our empirical study consists of two parts, the first of which is devoted to calculating the health system performance scores in Tunisia for the period 1990–2018 while using the DEA methodology as well as to propose possible solutions to increase the performance of this sector, in the second the studies will study the impact of factors likely to influence technical efficiency using the Tobit model.

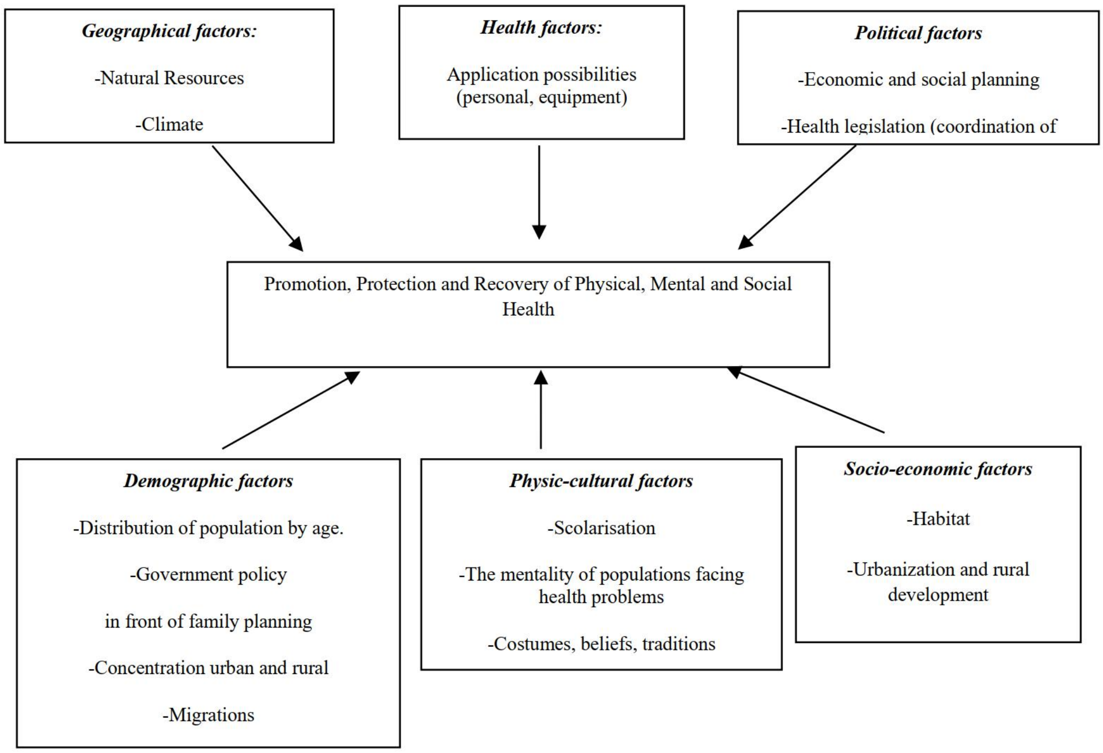

Figure 1. Medical and non-medical factors that influence human health

3.2. The DEA Methodology

The first work on the concept of efficiency was carried out by Farell (1957) who clearly defined the concept of economic efficiency; he was the first to distinguish between the concepts of technical and allocative efficiency. To measure efficiency, two major approaches have been developed: the parametric approach and the nonparametric approach Jia, T and al. (2017).

The parametric approach imposes a single production function for all firms, and more, it requires strong assumptions on the distribution of the error term. In contrast to parametric approaches, the non-parametric approach places no restrictions on the functional form of the production function and no assumptions on the error term. It gives a simple and aggregated measurement for each decision unit.

Historically, it was Farell (1957) who came up with the idea of measuring efficiency through the nonparametric border. This line of research was generalized by Charnes (1978) who developed the Data Envelopment Analysis (DEA) method. This method has made it possible to extend the analysis of technical efficiency to multi-product situations.

Data wrapping analysis involves using mathematical programming to construct a piecewise linear border from the set of data in production units. Later, Banker (1984) have proposed a model that allows relaxing this hypothesis, it is the model of the variable returns of scale.

Empirically, the DEA method has been widely used to measure the efficiency of production units in various sectors of activity Krejnus, M and al. (2023), particularly in the banking sector, in the agricultural sector, in the health sector, etc.

Several studies have shown that the non-parametric approach, notably the DEA method, presents several advantages over parametric approaches;

- It is concerned with individual observations rather than the means of a statistical population. That is, it processes the DMUs operating in the same sector one by one, giving for each the score and the sources of inefficiency.

- It allows a quantitative evaluation of performance for DMUs using multiple inputs to produce multiple outputs.
- It does not require restrictions on the values of the variables, on the weights and the form of the production function.
- It indicates the desirable changes in terms of inputs or outputs for inefficient DMUs.
- In its analysis, it incorporates quantitative variables as well as qualitative variables.

However, some limits have been made against the DEA method.

- First, the boundary function constructed by this method is deterministic, i.e. any deviation from the frontier is attributed to inefficiency and no random variation is taken into account.
- Second, the estimated border function is very sensitive to the extreme observations that are responsible for determining the border.
- Finally, the estimated border function has no statistical property allowing the application of hypothesis tests. The studies note that these problems can be solved by the parametric approach.

3.2.1. The Formulation of the DEA Method

To measure the efficiency of a unit: Charnes, and al. (1978), proposed the model (M1):

$$\text{Max } h_0 = (\Sigma\, U_r\, Y_{rj0}) / (\Sigma\, V_i\, X_{ij0}) \tag{1}$$

$$\text{Subject to: } (\Sigma\, U_r\, Y_{rj}) / (\Sigma\, V_i\, X_{ij}) \leq 1; \quad U_r, V_i \geq \varepsilon\, ;\, \forall\, r, i \tag{2}$$

Where Y_{rj} is the observed quantity of output r produced by unit j; X_{ij} is the observed quantity of input i used by unit j; U_r is the weight of the output r; V_i is the weight of the input i; N is the number of units; and ε is a very small positive quantity.

In the solution of the model (M1) the efficiency of the unit j is maximized under the constraint of the efficiency of all other units having 1 as upper bound including the efficiency j_0. So the maximum is reached when the efficiency of unit j_0 is equal to 1, this efficiency is relative to the efficiencies of all the other units. The unit j_0 would be inefficient if the maximum is less than 1.

The model (M1) is a fractional program; it can be solved as a linear program assuming the denominator of (M1) as constant and maximizes the numerator, the linearization of the model M1 is given by the model M2.

The linearization of the model (M1) is given by the model (M2: Primal Form):

$$\text{Max } h_0 = \Sigma\, U_r\, Y_{rj0} \tag{3}$$

Under constraint:

$$-V_i \leq -\varepsilon \tag{4}$$

$$\Sigma\, U_r\, Y_{rj} - \Sigma\, V_i\, X_{ij} \leq 0 \tag{5}$$

The studies can solve the dual of (M2) as the primal, if the studies have in the primal (t + m) variables then the dual has (t + m) constraint and if the studies have (i + j) constraint in the primal then the studies have (i + j) variable in the dual.

$$\text{Min } Z_0 - \varepsilon\, \Sigma\, s_r^+ - \varepsilon\, \Sigma\, s_i^- \tag{6}$$

Under constraint:

$$X_{ij0} - S_i^- - \Sigma\, X_{ij}\, \lambda_j = 0;\ i = 1\ldots m \tag{7}$$

$$-s_r^+ + \Sigma\, Y_{rj}\, \lambda_j = Y_{rj0};\ r = 1\ldots t \tag{8}$$

$$\lambda_j, S_i^-, S_r^+ \geq 0;\ \forall\, j, r \text{ and } i$$

λ_j, S_i^-, S_r^+ and Z_0 are dual variables. Z_0^* is the optimal value of Z_0 in (M3). The unit j_0 would be efficient in the Pareto sense if $Z_0^* = 1$ and S_i^-, S_r^+ are zero whatever i and r.

The weights V_i and U_r defined in the model M1 considered as dual variables associated respectively with the inputs or outputs. Banker and al. (1984) modified the model (M1), taking into account the non-constancy of scale returns. The model (M4) reports a measure of the efficiency "Pure technical" (input) of the unit j_0.

$$\text{Min } h - \varepsilon\, [\Sigma\, S_i^- + \Sigma\, S_r^+] \tag{9}$$

Under constraint:

$$h\ X_{ij0} - \Sigma\ X_{ij0}\ \lambda_j - s_i^- = 0;\ i = 1 \ldots m \tag{10}$$

$$\Sigma\ Y_{rj}\ \lambda_j - s_r^+ = Y_{rj0};\ r = 1 \ldots t \tag{11}$$

$$\Sigma\ \lambda_j = 1;\ \lambda_j,\ S_i^-,\ S_r^+ \geq 0 \tag{12}$$

The convexity constraint $\Sigma\ \lambda_j = 1$ allows us to ensure that (M4) gives a measure of the "purely technical" efficiency of the unit j_0. So the convexity constraint will ensure that a unit composed at the same scale size as the target unit j_0. The efficiency "Scale efficiency" given by the model (M3) is lower than that given by the model (M4), thanks to the constraint of convexity added to (M4). The measurements "Scale efficiency" given by (M3) and (M4) will be equal if and only if, there exists an optimal solution of (M3) such that $\Sigma\ \lambda_j = 1$.

The calculation of efficiency scores is based on the output-oriented approach (case of variable Scale Returns: VRS) first. This makes it possible to evaluate how much the input quantity has to be reduced without varying the quantity of output. In other words, how much should the studies reduce public spending in the health and number of doctors sector while keeping the same level of profitability of this spending (determination of efficiency).

In a second step, the studies will adopt the output-oriented approach (BCC) to assess the effectiveness of the health systems. This will allow us to determine the amount of output the studies can achieve for a fixed amount of input.

4. DEA and Econometric Conception

4.1. Choice of Inputs and Outputs and DEA Results

The selection of inputs and outputs calls into question the power of DEA in discriminating between units (Table 1). Each resource used by a unit must be included as input, and the latter will convert resources to produce outputs. The choice of inputs and outputs can be illustrated in the context of the health system in Tunisia for the period cover 1990–2022.

Table 1. Inputs and outputs selected

Inputs	Outputs
X1: Hospital beds (per 1000 people)	Y1: Healthy life expectancy at birth (years)
X2: Number of inhabitants per doctor	Y2: Survival to age 65, (% of cohort)
X3: Current health expenditure per capita, PPP (current international $)	

The studies use the DEA model for variable returns to scale to measure the efficiency of the health system in Tunisia for the period cover 1990 to 2022. The results obtained by the DEAP2.1 software are shown in the Table 2.

Table 2. Score efficiency between 1990 and 1999

Year	Score efficiency
1990	0.827
1991	0.796
1992	0.564
1993	0.568
1994	0.929
1995	0.715
1996	0.827
1997	0.978
1998	0.982
1999	0.987

The studies note from the results calculated for the technical efficiency of the health system in Tunisia for the period 1990–1999, is efficient and attains a score greater than 0.7 for the whole period except for the years 1992 and 1993 this score reached respectively from 0.564 and 0.568.

During this period the health system of Tunisia is considered among the best in Africa, with a life expectancy at birth of around 71 years on average. The diversification of the economy and the radical reforms to improve the standard of living of Tunisians have resulted in a credible health system, but one which needs serious improvement in terms of quality and equity of care. Another remark in terms of decentralization of health services, the studies note the existence of a regional imbalance manifested by a higher life expectancy in the coastal regions than in the western and southern regions.

Table 3. Score Efficiency between 2000 and 2010

Year	Score efficiency
2000	0.990
2001	0.994
2002	0.997
2003	1.000
2004	0.812
2005	0.950
2006	0.858
2007	0.956
2008	0.863
2009	0.824
2010	0.827

The health system is managed by the Ministry of Public Health based in Tunis. In the public sector, Tunisians have near-universal access to basic health care, although access to specialized care in rural areas is more limited. Most of the best specialists in the public sector work in university hospitals associated with the country's universities located in major cities.

For the period between 2000 and 2010 the studies notice a drop efficiency of the health system but it remains the performance turn and the studies can consider it efficient, thus the studies see that it is efficient for the years between 2000 and 2003 and month efficient between 2004 and 2006 (Table 3).

This success is due to the good economic performance of Tunisia during the 2000–2010 periods which enabled the country to experience greater prosperity and rapid poverty reduction. This period is marked by growth at been relatively inclusive, with the national poverty line falling from 32 to 16 percent between 2000 and 2010, and a considerable improvement in the per capita income of the poorest 40 percent of Tunisians (an increase of one third per capita). Public investments in human development have contributed to making significant improvements to reduce infant and maternal mortality as well as infant malnutrition at the national level. Education levels have also increased significantly. Excellent road infrastructure has been built across the country as well as ports and airports in addition to the infrastructure needed for information and communication technology.

Table 4. Score efficiency between 2011 and 2022

Year	Score efficiency
2011	0.829
2012	0.832
2013	0.834
2014	0.799
2015	0.767
2016	0.737
2017	0.710
2018	0.685
2019	0.661
2020	0.640
2021	0.619
2022	0.601

Table 4 showed after the year 2012, the health system in Tunisia experienced a fall towards inefficiency marked by poor hospital services provided by the public sector which led to the decrease in efficiency scores for the years 2018-2019-2020-2021 and 2022.

The drop in economic indicators and the drop in public power induced by economic difficulties after 2011 leads to the deterioration of the main economic aggregates, in particular, the GDP drops from 3.5% in 2010 to less than 1% in 2018 and even 1.1% in 2019; unemployment went from 13% in 2010 to 15.3% in 2018. There is also the brain drain. For example, the share of young exiled doctors increased from 9% in 2012 to 45% last year. The number of inhabitants per doctor also experienced a successive drop, following the brain drain, from 1825 inhabitants per doctor in 1990 to 728 in 2018. All these weak indicators led to the deterioration of the health system in Tunis after the year 2011.

Table 5. Levels of improvement required

Year	Indicator	Original	Projected	Improvement	Rate (%)
2011	Healthy life expectancy at birth	73.60	73.60	—	—
	Survival to age 65	83.90	83.90	—	—
	Hospital beds	2.1	2.1	—	—
	Inhabitants per doctor	780	780	—	—
	Current health expenditure per capita, PPP	650.96	650.96	—	—
2012	Healthy life expectancy at birth	73.28	73.28	—	—
	Survival to age 65	83.34	83.34	—	—
	Hospital beds	2.1	2.1	—	—
	Inhabitants per doctor	748	748	—	—
	Current health expenditure per capita, PPP	700	700	—	—
2013	Healthy life expectancy at birth	73.49	73.973	0.48	0.655
	Survival to age 65	83.61	84.123	0.52	0.616
	Hospital beds	2.10	2.1	—	—
	Inhabitants per doctor	772	772	—	—
	Current health expenditure per capita, PPP	750.66	692.372	-58.28	-7.764
2014	Healthy life expectancy at birth	73.7	76.227	2.527	3.428
	Survival to age 65	83.87	86.699	2.827	3.370
	Hospital beds	2.2	2.2	—	—
	Inhabitants per doctor	777	777	—	—
	Current health expenditure per capita, PPP	771.73	731.603	-40.13	-5.199
2015	Healthy life expectancy at birth	73.903	76.141	2.238	3.028
	Survival to age 65	84.136	86.648	2.512	2.985
	Hospital beds	2.3	2.300	—	—
	Inhabitants per doctor	769	769	—	—
	Current health expenditure per capita, PPP	802.07	753.536	-48.53	-6.051
2016	Healthy life expectancy at birth	74.10	79.908	5.806	7.835
	Survival to age 65	84.40	90.928	6.528	7.734
	Hospital beds	2.4	2.4	—	—
	Inhabitants per doctor	808	808	—	—
	Current health expenditure per capita, PPP	806.34	787.753	-18.59	-2.305
2017	Healthy life expectancy at birth	74.30	77.199	2.902	3.905
	Survival to age 65	84.66	87.929	3.265	3.856
	Hospital beds	2.5	2.5	—	—
	Inhabitants per doctor	768.0	768	—	—
	Current health expenditure per capita, PPP	810.62	801.321	-9.30	-1.146
2018	Healthy life expectancy at birth	74.49	74.49	—	—
	Survival to age 65	84.93	84.93	—	—
	Hospital beds	2.6	2.6	—	—
	Inhabitants per doctor	728.0	728.0	—	—
	Current health expenditure per capita, PPP	814.89	814.89	—	—

It is clear from this study that the reason for the inefficiency of health system is primarily due to the failure of health public to achieve relative efficiency according to the (BCC) model, which means that the inefficiency is caused by the failure to utilize the resources in the optimal, and the regulations necessary to make it more efficient are presented in the Table 5.

The studies note from our results that from 2013 to 2017 the health system in Tunisia is inefficient; this inefficiency is mainly caused by poor management of resources in terms of budget, also, the poor distribution of public health care. Consequently, the state must rationalize its expenditure. For the year 2013, the health ministry's must reduce their spending by 7.76% to improve their efficiency levels and improve their health performance, which leads us to note the movement in budgetary resources in terms of health. Pharmaceuticals are not widely available in the public health sector, which forces patients to acquire them in private pharmacies. Access to essential medicines is severely affected by insufficient funding of public structures and by corruption which is the main factor in the deterioration of performance and the lack of confidence of the people towards their manager. This remark of poor distribution of expenditure and corruption is the same for the periods from 2014 to 2017; in fact, the state must rationalize its health expenditure to decrease by 5.19%, 6.05%, 2.3%, and 1.14% respectively. In the same way, the state must improve its health results with the same use of these resources, therefore the life expectancy at birth must be 76 years instead of 73 years in 2014, likewise in 2015 and 2016.

According to this empirical investigation, the studies note that the results are given by the health system in Tunisia for the period cover 2012–2018 (after the revolution) do not reach efficiency, indeed it is necessary to pass to radical reforms to support health and then improve health services to the public. In what follows the studies will stimulate the impact of structural variables on the improvement of performance and health efficiency through a Tobit model.

4.2. Econometric Analysis

The efficiency scores obtained, do not only reflect the management errors attributable to the leaders, but also the structural environment specific to each country. In what follows, the studies will try to establish a relationship between the level of efficiency and some structural variables, organizational, strategic and/or environmental. Thus, the efficiency scores were regressed on certain variables characterizing the inefficiency. The estimated Tobit model considering the available data is as follows:

$$\mathbf{Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \beta_3 X_{3t} + \beta_4 X_{4t} + \varepsilon_t} \quad \mathbf{(13)}$$

where:

- Y_t: Score of efficiency calculated with the DEA method (EFF).
- X_{1t}: Physicians (per 1000 people) (PH).
- X_{2t}: Hospital beds (per 1000 people) (BEDS).
- X_{3t}: Poverty headcount ratio at $3.20 a day (2011 PPP) (% of the population) (POV).
- X_{4t}: Population density (people per square kilometer of land area) (DENS).

The results according to the Tobit model are given in the Table 6.

Table 6. Factors Explaining Technical Efficiency (Tobit Model)

Variables	Coefficient	T-Student	P-Value
PH (X1)	0.025	0.067	0.508
BEDS (X2)	0.027	1.86	0.074
POV (X3)	-0.012	14.94	0.000
DENS (X4)	-0.007	10.38	0.000

with regard with the Table 6, it can be seen that the following results:

- A positive and insignificant relationship between the number of doctors per 1000 inhabitant and the health efficiency in Tunisia, this leads us to note that the state must act this factor to improve the health system specifically to fight against the immigration of executives in particular by the high rate of this phenomenon, especially after the revolution. Consequently, he must find legislative as well as financial regulations to encourage executives to settle in Tunisia since each training of a doctor for the community between 8 and 9 thousand Tunisian dinars each year.

- There is also a positive and significant relationship of around 2.7% between the number of beds and efficiency, indeed a strategy aims to increase health performance in Tunisia can result in patient satisfaction in terms of bed, thus a State investment strategy in terms of increasing hospital capacity can improve health efficiency.
- Concerning the economic variable chosen, poverty, there is an inverse relationship between poverty and efficiency. This result shows the inverse causality between poverty and health performance of around 1.2%, so the state must fight against poverty to support the health system.
- About the demographic variable, the population density finds a negative and significant relationship of the order of 7%, so high population density leads to increased inefficiency.

5. Conclusion

This work aimed to calculate the technical efficiency of the health system in Tunisia for the period from 1990 to 2018, subdivided into three phases, the phase between 1990 and 1999, 2000 and 2010 and finally the phase after the revolution between 2011 and 2018 by using the DEA methodology and based on the concept of production border. The results obtained show that technical efficiency differs from one phase to another. In the first phase 1990–1999 we see that the Tunisian health system remains efficient and closer to efficiency, during the 2000 and 2010 phase health also remains more efficient with efficiency scores around 1, but after the revolution especially the years between 2012 and 2017 there is a less efficient system and far from efficiency, this can be explained by the decrease in the role of the state in the public sector, by the deterioration of the main economic indicators especially that reflect poverty and social aspects, also the massive immigration of Tunisian executives and their orientation towards the foreign market.

Beyond this fearfully descriptive aspect, we have introduced certain explanatory elements of the efficiency scores by establishing a relationship between the level of efficiency and certain variables likely to improve health performance in particular, the number of doctors per 1000 inhabitant, the number of beds, poverty index and population density while looking at a Tobit model. The results indicate that the government can use efficiency variables, economic, social and demographic variables to boost health system performance. We note in this context a positive relationship between efficiency and the number of doctors as well as the number of beds and a negative relationship with the poverty index and population density.

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