International Journal of Strategic Management and Economic studies (IJSMES)
ISSN: 2791-299X

Eradicating Malaria in Benin: Does the Productive Efficiency of Public Hospitals Matter?

Calixe Bidossessi ALAKONON[1*] and Alastaire Sèna ALINSATO [2]

[1]Laboratory of Public Economics, University of Abomey-Calavi, Benin,

ORCID: 0000-0002-8830-1988

[2]Laboratory of Public Economics, University of Abomey-Calavi, Benin,

ORCID: 0000-0002-5307-8413

**Corresponding author*

Abstract: This paper analyses the Determinants of the productive efficiency of public hospitals in Benin. Using panel data collected from 12 Benin's departments over the period 2013-2017, the results show that the average efficiency score is 67.18%. This reflects significant levels of inefficiencies. In addition, estimates from a Tobit model show that, the attendance rate, the number of medical staff, and the number of nursing staff positively explain the efficiency scores. However, population density acts negatively. These results suggest that measures to improve the attendance rate and increase in health personnel as a function of density in departments are needed to increase the efficiency of public hospitals in eradicating malaria.

Keywords: Productive efficiency; public hospitals; malaria

Digital Object Identifier (DOI): https://doi.org/10.5281/zenodo.7320177

Published in: Volume 1 Issue 2

1. Introduction

One of the important economic and social concerns of developing countries, especially in the context of achieving the Sustainable Development Goals, is improving the health status of populations. Countries have been demonstrating their concern for the health system by investing more in it and by implementing adequate reforms to improve public health system efficiency. This combination of both investments and reforms suggests that the issue of the efficiency of the health sector is at the heart of the concerns of public authorities and populations (Alinsato and Alakonon, 2021; Nundouchan, 2020; Kaya Samut and Cafr, 2015; Kirigia and Asbu, 2013).

For several decades, following different approaches to measuring efficiency, there has been a great deal of empirical work on determining the efficiency of health systems in all countries, particularly in developing countries to better guide economic policies. For eradicating malaria, the World Health

Organization (WHO) has promoted a dynamic to countries for decades, especially African countries for more efficient results. For example, in 2016, WHO launched the Global Technical Strategy for Malaria Control 2016-2030 by identifying four targets to be achieved by 2030 worldwide, as well as interim targets to monitor the progress. The targets for 2030 are a reduction of at least 90% in the incidence of malaria cases; a reduction of malaria mortality rates by at least 90%; an elimination of malaria in at least 35 countries in Africa; and prevent a resurgence of malaria in all countries that are free from it (WHO, 2020).

Based on this strategy, African countries committed through the Abuja Declaration in 2000 to halve the number of malaria deaths on the continent over the next 10 years. In this dynamic, Benin has undertaken several actions to eradicate malaria. These include free distribution campaigns for insecticide-treated nets, intermittent preventive treatment during pregnancy and management of malaria in children (The DHS Program, 2020). Whose budget of the Ministry of Health increased from 113 million US$ in 2019 to 126 million US$ in 2020, indicating an annual growth rate of about 11.5%.

Despite these efforts, Benin is one of the 15 countries in sub-Saharan Africa most affected by malaria, with 80% of deaths (WHO, 2021). The Benin health statistics in 2019 showed that malaria continues to be the first cause of death and accounts for 40% of the total health demand. Equally, the average incidence of malaria (simple and severe) tested positive increased from 12.5% in 2013 to 21.2% in 2019. Besides, the average lethality of malaria remains unchanged from 2013 to 2019 at 1.3 (SGSI/DPP/MS, 2013; 2019). Malaria is thus a major public health problem in Benin and remains a major source of death beyond its public finance burden.

Since 2020, the COVID-19 pandemic has become an additional constraint to the provision of essential health services around the world. The onset of COVID-19 makes it much more difficult to respond to malaria around the world, and the WHO is concerned that even moderate disruptions in access to treatment could result in a significant number of deaths. Thus, according to the report, a 10% disruption in access to effective malaria treatment in sub-Saharan Africa could lead to an additional 19,000 deaths in the region (WHO, 2020).

Towards the goal of eliminating malaria by 2030, this paper wonders what are the main Determinants of the productive efficiency of public hospitals? The purpose of this paper is to examine the determinants of the productive efficiency of public hospitals in eradicating malaria in Benin. To the best of our knowledge, no study on the efficiency of the health system has specifically addressed the examination of the determinants of the efficiency of public hospitals in eradicating malaria in Benin. Thus, this paper fills this gap in the literature. But it will also help guide economic policy measures in the context of COVID-19, where it seems that countries no longer have malaria as a priority. To do this, we will use the two-step Data Envelopment Analysis (DEA) approach.

The rest of this article is organized into three parts. The first part provides an overview of the literature. The methodology is addressed in the second part. The third part discusses the results and the conclusion.

2. Literature review

The economic literature has widely investigated the efficiency of health systems to guide policymakers. In the general framework of analysis of hospital efficiency, we note for example the work of Ng (2011) carrying the productive efficiency of Chinese hospitals. Based on the DEA approach, he studied the sources of the inefficiency of hospitals in China. The results show that the stage of economic development does not explain the efficiency of the hospital rather the hospitals' behaviour and technological progress. Equally, Gai et al. (2010) examined trends in the productive efficiency of Chinese hospitals during the economic transition using data from 1993 to 2005. Using the DEA approach, they calculated the overall efficiency and the pure technical efficiency of a sample of hospitals

across 31 provinces. The results show that hospitals are inefficient. The inefficiency is mainly driven by the geographical disparities in the allocation of health resources and the productivity of hospitals.
Recently, Nundouchan (2020) analysed the trend of hospital technical efficiency over the period 2001-2017 in Mauritius using Cobb Douglas, Translog and Multi-Production functions. The author estimated efficiency scores as 0.83, 0.84 and 0.89, respectively. He further indicated that the number of nurses and beds are the most important factors in hospital output. Thus a 1% increase in the number of beds and nurses results in an increase in hospital output by 0.73% and 0.51%, respectively. However, if hospitals need to increase their inputs by 1%, their outputs will increase by 1.16% the author concluded that the creation of tax space through total technical efficiency is estimated to be 8.9 and 9.2 per cent of GHGs in fiscal years 2021-2022 and 2022-2023, respectively.
Furthermore, Sultan and Crispim (2016) examined the technical and scale efficiency of Jordanian public hospitals. The study applied oriented inputs DEA approach under constant and variable return to scale to classify hospitals and attribute factors associated with inefficient operations. The results revealed that 25 out of 135 observations were fully efficient. Eight hospitals in 2014 were fully efficient, but performing poorly and all experienced slowdowns. Similarly, Dimas, Goula and Soulis, (2010) analysed, productive performance and its components in Greek public hospitals. The results show, that changes in productivity were dominated by the technical change while the inefficiency of hospitals was attributed to an excessive increase in their spending. These studies show the inefficiency of countries' health systems and formulate improvement measures.
In terms of analysis of the efficiency of hospitals in the treatment of a specific disease, Hanson (2004) in the economic analysis of the role of public and private hospitals in eradicating malaria, made advocacy and high-level debate on how to increase the availability and uptake of effective malaria interventions. Hanson (2004) indicated that market failures occur for some effective malaria interventions due to monopolies, externalities and information failures, involving a role in public action. In addition, Atake (2016) evaluated the efficiency of malaria control policies in 30 malaria-endemic sub-Saharan African (SSA) countries from a sustainable gains perspective. He used the double bootstrap method to first calculate and then a truncated bootstrap regression was used to determine the factors associated with the efficiency of the malaria program. The results show that most SSA malaria programs are technically inefficient. Moreover, these results revealed that foreign aid and public spending on malaria control programs do not significantly affect the efficiency of malaria control programs. However, international aid and public spending have a positive impact on the efficiency of malaria control programs when the quality of governance is improved. In addition, intermittent preventive treatment for pregnant women is associated with a positive effect on efficiency.
From this literature, it is noted that health systems are generally inefficient in the provision of health services due to countries' socioeconomic and institutional factors. Thus, this work aims at examining the determinants of the productive efficiency of public hospitals in eradicating malaria in Benin in the context of COVID-19.

3. Methodology

In this paper, we use, the two-step DEA method to examine the determinants of the productive efficiency of public hospitals in the twelve (12) departments[1] in Benin.

3.1 Data Envelopment Analysis approach

The determination of the efficiency of a decision or production unit is generally based on the analysis of production frontiers since the early ideas of Koopmans (1951) and Debreu (1951) with the founding

[1] ALIBORI ; ATACORA ; ATLANTIQUE ; BORGOU ; COLLINE ; COUFFO ; DONGA ; LITTORAL ; MONO ; OUEME ; PLATEAU ; ZOU

work of Farrell (1957) in the calculation of productive efficiency. The pioneering work of Farell (1957) on the theoretical framework of efficiency measurement shows that the productive efficiency of firms corresponds to the best use of resources. He distinguished three approaches. The technical efficiency, when the unit can produce the maximum possible yields by using a given amount of inputs. On the other hand, Farell distinguished allocative efficiency, which refers to an optimal combination of inputs deployed at a minimum cost to produce a given quantity of production. In this case, any change in the combination of inputs employed by maintaining the same output will result in additional cost implications. Finally, the third measure of efficiency is the economic efficiency which is obtained when both technical and allocative efficiencies are met. In this respect, it is more appropriate to study technical efficiency in a field of public production such as hospitals or the services provided are not for profit.

Through the literature, we consider that the DEA method is more compatible for determining the productive efficiency of public hospitals because of the existence of multiple inputs and outputs technology on the one hand. On the other hand, production technology is difficult to model and prices are not known in our context. Indeed, in the situation of a multi-input and multi-product technology, efficiency can be written:

$$\boldsymbol{ET_k} = \frac{\sum_{r=1}^{s} \boldsymbol{U_r Y_{rk}}}{\sum_{i=1}^{m} \boldsymbol{V_i X_{ik}}} \qquad (\mathbf{1})$$

Where ($\mathbf{0} < \boldsymbol{ET_k} \leq \mathbf{1}$)

In equation $\boldsymbol{ET_k}$ is the productive efficiency of the production unit k using m inputs to produce s outputs; Y_{rk} is the quantity of output r produced by the unit of production k; X_{ik} is the quantity of the input i consumed by the unit k, U_r and V_i are the respective weights of the output r and the input i; n is the number of production units to be evaluated; m and s the respective numbers of input and output.

Assuming that there are n hospitals, each with m admissions and s discharges, the relative efficiency score of a given hospital (ET) is obtained by solving the following output-oriented CCR linear programming model:

$$\text{Max } \frac{\sum_{r=1}^{s} \boldsymbol{U_r Y_{rk}}}{\sum_{i=1}^{m} \boldsymbol{V_i X_{ik}}} \qquad \mathbf{(2)}$$

$$\text{Subject to} \begin{cases} \frac{\sum_{r=1}^{s} \boldsymbol{U_r Y_{rk}}}{\sum_{i=1}^{m} \boldsymbol{V_i X_{ik}}} \leq \mathbf{1} & (\mathbf{3}) \\ \boldsymbol{U_r}, \boldsymbol{V_i} \geq \mathbf{0} & (\mathbf{4}) \\ r = 1, \ldots . s; i = 1, \ldots m \text{ and } j = 1, \ldots n & (\mathbf{5}) \end{cases}$$

The CCR model assumes constant returns to scale, which means that all observed combinations of production can be increased or reduced proportionally, i.e. not allowing economies or diseconomies of scale. In other words, the model assumes that DMUs can linearly be scaling inputs and outputs without increasing or decreasing efficiency (Charnes, Cooper and Rhodes, 1978). The CCR excludes the existence of variable returns to scale, where variable returns to scale refer to changes in hospital outputs as hospital inputs change in the same proportion.

Suppose a hospital increases the differents inputs used by the same proportion. Three scenarios are possible: (i) the production (s) increases with the increase in inputs, which implies constant returns to scale; (ii) the production (s) increases more than the increase in inputs, which implies increasing returns to scale; or (iii) the output (s) increases less than the increase in inputs, which implies diminishing returns to scale (Koutsoyiannis, 1979).

A hospital may exhibit constant returns to scale, increasing returns to scale, or decreasing returns to scale depending on whether it experiences economies of scale or diseconomies of scale. Constant returns to scale occur when economies of scale are exhausted and health system inputs are perfectly divisible. The presence of increasing returns to scale may indicate indivisibilities in certain hospital inputs (e.g. diagnostic equipment, operating room) and a greater possibility of specialization of health personnel as the scale/size of the hospital production increases. On the other hand, decreasing returns to scale can arise when large-scale production results in cumbersome lines of communication between the hospital's general management and health personnel, resulting in a decrease in managerial efficiency. Decreasing returns to scale could also occur due to the overuse of an entrepreneur's abilities and skills (Koutsoyiannis, 1979).

Therefore, applying the CCR model where hospitals are not performing at an optimal scale results in technical efficiency scores that are contaminated by scale efficiencies. To circumvent this problem, Banker, Charnes and Cooper (1984) introduced a slight modification in the CCR model to end up with a BCC model which allows the estimation of pure technical efficiencies. Consequently, we estimated variable returns to scale (VRS) on the scale results of the following BCC model:

$$Max\ \emptyset_k + \varepsilon \sum_{r=1}^{s} S_r + \varepsilon \sum_{i=1}^{m} S_i \qquad (\mathbf{6})$$

$$\text{Subject to} \begin{cases} \emptyset_k y_{rk} - \sum_{r=1}^{n} \lambda_j y_{rj} + S_r = 0, r = 1, \dots, s & (\mathbf{7}) \\ x_{ik} - \sum_{j=1}^{n} \lambda_j x_{ij} - S_r = 0, r = 0,\ i = \cdots, m & (\mathbf{8}) \\ \lambda_j\,; S_r\,;\ S_i \ \geq 0\ \forall\ j = 1, \dots., n\,; r = 1, \dots s; i = 1, \dots., m & (\mathbf{9}) \\ \sum_{j=1}^{n} \lambda_j = 1 & (\mathbf{10}) \end{cases}$$

A hospital is considered technically efficient if it scores one, implying a relative technical efficiency of 100%, while a score below one implies that it is technically inefficient compared to others as a set of efficiencies benchmark. This inefficiency may depend on considering that health workers only treat malaria or treat other diseases as well. But this situation is controlled by the context of African countries in terms of malaria where almost every individual is a carrier of malaria. Therefore, all nursing staff systematically include the consideration of this disease in the treatment diagnoses of any patient. So, the inefficiency that will be observed emanates from the socioeconomic factors of the departments. This shows the need to identify the determinants of the productive efficiency of public hospitals to guide economic policies.

3.2 Tobit model

In the literature, the sensitivity of efficiency scores to certain socio-economic variables is a major concern in terms of the approach that allows reliable results. For some authors, in particular, Simar and Wilson (2007) show that the efficiency scores calculated from the DEA method are biased on the one hand, and on the other hand, the inputs and outputs are correlated with the socio-economic variables, thus the conventional statistical inferences are not valid in the second stage regression. They suggested using the double bootstrap method. On the other hand, others argued that econometric models such as probit, logit and Tobit are suitable for a second stage estimation of the DEA method in determining factors explaining the efficiency of production units (Kirigia and Asbu, 2013; Ramalho et al., 2010; McDonald, 2009). In this sense, Afonso and Aubyn (2011) demonstrated that based on a set of assumptions about the data generation process and the distribution, disturbance terms can be distributed. So it is not clear that the results of the bootstrap estimates are necessarily more reliable than the results of the Tobit model even if the results of the latter are possibly biased. By doing the empirical verification, they found that the censored normal Tobit results and the bootstrap algorithms gave very similar results. So to study the explanatory factors of the efficiency scores of public hospitals in Benin, we adopt the Tobit regression model because the efficiency scores determined by DEA at the first are between 0 and 1. The model is specified as:

$$\boldsymbol{ET_k} = \begin{cases} \boldsymbol{\beta_j X_k + U_k}\,; \boldsymbol{si\ ET^*} > \mathbf{1} \\ \qquad \mathbf{0}\ \boldsymbol{sinon} \end{cases} \qquad \mathbf{(11)}$$

ET_k is the efficiency score of hospitals and $X_k$the vector of explanatory variables.

The functional form of the model is as follows:

$$\mathbf{score_{it}} = \boldsymbol{a_0} + a_1 \text{Nprivmedic}_{\mathbf{it}} + a_2 \text{Npubmedic}_{\mathbf{it}} + a_3 \text{Equipexpendi}_{\mathbf{it}} + a_4 \text{Operaexp}_{\mathbf{it}} + a_5 \text{Heatcenattrat}_{\mathbf{it}} + a_6 \text{Popdensit}_{\mathbf{it}} + a_7 \text{Lifexpbir}_{\mathbf{it}} + \boldsymbol{\alpha_{it}}$$

Where score_{it} are the efficiency scores of hospitals in the department i at period t is the intercept term;a_1, a_2, a_3 a_4, a_5 , a_6 and a_7 are the unknown parameters or coefficients to be estimated and is the stochastic error term.

3.3 Variables and data source

Data used in this paper come from the health statistics directories of the Benin Ministry of Health and concern the hospitals of the twelve departments over the period from 2013 to 2017. The choice of variables is based on the literature.

3.3.1 Table 1

Malaria-related lethality (refers to the number of deaths due to malaria during the year compared to the total number of new cases of severe malaria in the year. Allows monitoring of the quality of the curative management of cases within the hospitals).

Table 1. Description of variables

Variables	Description	Nature
MalariaLet	Malaria-related lethality (refers to the number of deaths due to malaria during the year compared to the total number of new cases of severe malaria in the year. Allows monitoring of the quality of the curative management of cases within the hospitals)	Output
IncidMalar	Incidence of malaria (Provides information on how quickly malaria spreads in a population and helps assess the resources needed for case management)	Output
Npubmedic	Number of public medical and paramedical staff	Input
Puheatexp	Public health expenditure (Equipment expenditure + operating expenditure)	Input
Nprivmedic	Number of private medical and paramedical staff	Determinant
Equipexpendi	Equipment expenditure	Determinant
Operaexp	Operating expense	Determinant
Heatcenattrat	Health centre attendance rate	Determinant
Popdensit	Population density	Determinant
Lifexpbir	Life expectancy at birth	Determinant

Authors (2022)

4. Empirical results

4.1 Table 2

Table 2 below presents descriptive statistics for the variables used in the analyses.

Table 2. Descriptive statistics of the variables

Variable	Obs	Mean	Std. Dev.	Min	Max
MalariaLet	60	1.027	.678	.2	2.8
IncidMalar	60	14.568	6.331	4.8	28.8
Npubmedic	60	370.317	252.108	72	1137
Puheatexp	60	1.382e+08	1.289e+08	15320000	7.834e+08
Heatcenattrat	60	48.613	13.556	23	82.3
Popdensit	60	1154.312	3118.301	28	12827.92
Nprivmedic	60	377.767	447.837	59	1615

Authors (2022)

4.2 Productive efficiency of public hospitals

4.2.1 Table 3

After estimating the production frontiers, Table 3 below gives the summary statistics for the productive efficiency scores in terms of variable return to scale (VRS) of public hospitals in the twelve (12) departments of Benin. Analysis of this table shows us that the average productive efficiency of hospitals over the study period is 67.18% over the study period. This implies that hospitals can increase their production, that is to say, limiting the death rate due to malaria on the one hand, and slow down the speed of the spread of malaria in the country by 32.82% without the increased inputs used. This mainly shows the inefficient use of factors that are under the control of departments. This result is consistent with that of Atake (2016), who showed that public hospitals in sub-Saharan Africa are inefficient in eradicating malaria. This shows that public hospitals in Benin are as inefficient in malaria treatments as its peer of Subsaharan Africa countries. Thus, better management of health staff with more efficient use of the equipment and operating resources would be necessary to enable eradicating malaria more efficiently in Benin.

A comparative analysis shows that the hospitals of the departments of Donga are more efficient in eradicating malaria with an efficiency score of 92.01%. While the Littoral department is the least efficient with an average efficiency score of 25.79% over the study period. This could be explained by the characteristics of the populations of Littoral. Which shows that the public hospital serving a wealthier district has relatively lower efficiency, as people with better economic status prefer to receive better quality services from private hospitals. This reflects the socio-economic reality of the Littoral department to some extent.This agrees with Guo et al. (2017).

Given this level of efficiency of public hospitals in Benin, it is necessary to improve the level of efficiency of hospitals to eradicate malaria. This would be possible by controlling the determinants of hospital efficiency to increase their performance since this inefficiency can be explained by factors that are not under the control of hospitals.

Table 3. Results of estimation of hospital efficiency scores

Departments	2013	2014	2015	2016	2017	Mean/department (%)
ALIBORI	0.6909	0.3326	0.6744	0.3862	0.5647	**52.97**
ATACORA	0.7771	1.0000	1.0000	0.7991	0.9809	**91.14**
ATLANTIQUE	0.5989	0.3678	0.3874	0.5355	0.5800	**49.39**
BORGOU	1.0000	0.6716	0.6381	0.2808	0.5394	**62.59**
COLLINE	0.7323	0.7735	1.0000	0.5893	0.6535	**74.97**
COUFFO	0.7661	0.9197	0.7074	0.8717	0.8828	**82.95**
DONGA	1.0000	0.8818	0.9478	1.0000	0.7714	**92.01**
LITTORAL	0.3022	0.3202	0.2167	0.1657	0.2847	**25.79**
MONO	0.6932	0.6554	0.6453	0.8223	0.8390	**73.10**
OUEME	0.4739	0.5763	1.0000	0.3144	0.1639	**50.56**
PLATEAU	0.9487	1.0000	1.0000	0.6153	0.7360	**86.00**
ZOU	0.5315	0.4372	1.0000	0.8074	0.4632	**64.78**
Mean/year (%)	**70.95**	**66.13**	**76.80**	**59.89**	**62.16**	**67.18**

Authors (2022)

4.3 Determinants of hospital efficiency scores

4.3.1 Table 4

The results, as presented in Table 4, show that the coefficients associated with the number of public medical and paramedical personnel and the number of private medical and paramedical personnel are significantly positive. So any increase in health workers in both public and private hospitals in the departments will improve the efficiency of the eradication of malaria in Benin. This could be explained by the fact that the physician's per capita ratio is low in Benin and is below the WHO standard. Thus, the increase in health workers in the departments will help improve this ratio. Recruitment as a health worker for departments in favour of public hospitals is strongly recommended on the one hand, but on the other hand, to create better conditions for the private sector for the recruitment of health workers to compensate for the lack of medical density. These results show that it is the reduction of shortages of health personnel that will improve the technical efficiency of health systems. This is consistent with the work of (Andrews, 2020; Ali, Debela and Bamud, 2017).

Also, our results reveal that the attendance rate of populations in health centers positively and significantly explains the productive efficiency of hospitals in eradicating malaria in the departments of Benin. These results can be justified by the fact that the more the populations will develop the habit of going to the hospital in the event of malaria disease to so much, that will allow the health workers to better control the care by administering adequate treatment to avoid the risk of patient death. It is, therefore, necessary to adopt incentive measures about the population to increase the attendance rate of the population to eradicate effectively malaria. Incentives are even more necessary in the current context of the covid-19 pandemic crisis, where there is a psychosis of fear among populations of going to hospitals on the one hand, and on the other hand, the measures response limits the displacement that can prevent malaria control campaigns. This is the concern of WHO that moderate disruptions in access to treatment will result in significant numbers of deaths. Thus, according to the report, a 10% disruption in access to effective antimalarial treatment in sub-Saharan Africa could lead to an additional

19,000 deaths in the region. Disturbances of 25% and 50% in the region could result in an additional 46,000 and 100,000 deaths, respectively (WHO, 2020).

Likewise, the coefficient for the capital expenditure variable is positively significant. So the inefficiency of hospitals in eradicating malaria is linked to the lack of adequate equipment in the departments. Because the lack of equipment in public health centers does not allow adequate treatment to be administered to patients and there are more deaths from malaria. This shows that to eradicate malaria effectively, the government should better equip hospitals. Thus, it is by remedying the lack of investment in hospital capacity and technology that will improve the technical efficiency of public hospitals. This is in line with the work of Andrews (2020) on New Zealand.

Furthermore, the population density variable has a negatively significant coefficient. This result indicates that any increase in the population in the departments will deteriorate the productive efficiency of hospitals. This increase in the population will lead to a fall in the ratio of health workers per capita. This could degrade the level of care of patients by the physicians and lead to deaths due to malaria. Thus it is necessary to integrate the evolution of the population into the measures to eradicate malaria. So, the population variable becomes an important control variable in increasing the efficiency of public hospitals. This result are in line with that of Ahin, Lgün and Sönmez (2021).

Table 4. Estimation of the Tobit panel model

Variables	Coef.
Nprivmedic	0.25**
	(2.14)
Npubmedic	0.572***
	(3.29)
Equipexpendi	0.0001***
	(3.09)
Heatcenattrat	0.0004**
	(2.19)
Popdensit	-0.26*
	(-1.65)
Lifexpbir	0.018
	(1.38)
Operaexp	0.0002
	(1.40)
Constant	-1.292*
	(-1.73)

Auteurs (2022) ; **** p<.01, ** p<.05, * p<.1*

5. **Conclusion**

In this work, we studied the Determinants of productive efficiency of public hospitals in eradicating malaria at the level of the departments of Benin. We used the two-step DEA method, which is more suited to our study context where there are several inputs and outputs whose modelling of the production technique is difficult to represent. The determination of the efficiency scores shows that the average productive efficiency in the twelve departments of the country is 67.18%. This shows that there is still room for improving malaria eradication without increased expenditure on equipment and health workers in the hospitals. This could be explained by socioeconomic and institutional factors of the country. The estimation by the maximum likelihood method of the Tobit model of the determinants of the efficiency scores shows that the number of public medical and paramedical personnel, the number of private medical and paramedical personnel, the attendance rate of the populations and the capital expenditure positively and significantly influence the efficiency scores of hospitals. While the population density has a negative and significant sign on the efficiency scores. These results suggest that to eradicate malaria in Benin, policymakers should recruit sufficient healthcare personnel and strength the technical unit of hospitals, both in the public and in the private sector. Besides, incentive measures should be provide to increase the attendance rate of health centers.

Our future research will address the comparative study of the efficiency of public and private hospitals on the one hand. And on the other hand, will appreciate the influence of collaboration or competition between public and private hospitals on the efficiency of the health system which is not taken into account in this paper.

Reference

[1] Afonso, A., & St. Aubyn, M. (2011). Assessing health efficiency across countries with a two step and bootstrap analysis. Applied Economics Letters, 18(15), 1427–1430. doi:10.1080/13504851.2010.541149

[2] Ali, M., Debela, M. and Bamud, T. (2017). Technical efficiency of selected hospitals in Eastern Ethiopia, Health Economics Review 7, 24. https://doi.org/10.1186/s13561-017-0161-7

[3] Alinsato, A. S., & Alakonon, C. B. (2021). Determinants of Productive Efficiency of Public Service: What Effect of the Interaction of Corruption Control and Average Wage? Theoretical Economics Letters, 11, 1055-1066. https://doi.org/10.4236/tel.2021.116067

[4] Andrews, A.(2020). Investigating technical efficiency and its determinants: The Case of New Zealand District Health Boards, Health Policy and Technology, Volume 9, Issue 3, Pages 323-334, https://doi.org/10.1016/j.hlpt.2020.04.006

[5] Atake, E.-H. (2016). Sustaining Gains in Health Programs: Technical Efficiency and its Determinants in Malaria Programs in Sub-Saharan Africa. Applied Health Economics and Health Policy, 15(2), 249–259. doi:10.1007/s40258-016-0294-6

[6] Banker RD, Charnes A, Cooper WW (1984). Some models for estimating technical and scale inefficiencies in data envelopment analysis. Management Sciences 1984, 30(9):1078– 1092

[7] Charnes, A. , Cooper, W.W. et Rhodes ,E (1978). Measuring the efficiency of decision making units. European Journal of Operations Research, 2:429–444

[8] Dimas, G., Goula, A., & Soulis, S. (2010). Productive performance and its components in Greek public hospitals. Operational Research, 12(1), 15–27. doi:10.1007/s12351-010-0082-2

[9] Farrell, M. J. (1957). The Measurement of Productive Efficiency. Journal of the Royal Statistical Society. Series A (General), 120(3), 253. doi:10.2307/2343100

[10] Gai, R. and al.(2010). Health resource allocation and productive efficiency of Chinese county hospitals: Data from 1993 to 2005 ; *BioScience Trends*.; 4(5):218-224

[11] Guo, H. and al. (2018). Correction: Hong Kong Hospital Authority resource efficiency evaluation: Via a novel DEA-Malmquist model and Tobit regression model. *PLOS ONE*, 13(2), e0193266. doi:10.1371/journal.pone.0193266

[12] Hanson, K. (2004). Public and private roles in malaria control: the contributions of economic analysis. *American Journal of Tropical Medicine and Hygiene*, 71, pp. 168–173

[13] Kaya Samut, P., & Cafrı, R. (2015). Analysis of the Efficiency Determinants of Health Systems in OECD Countries by DEA and Panel Tobit. *Social Indicators Research*, 129(1), 113– 132. doi:10.1007/s11205-015-1094-3

[14] Kirigia, J. M., and Asbu, E. Z. (2013). Technical and scale efficiency of public community hospitals in Eritrea: an exploratory study. *Health Economics Review, 3(1), 6.* doi:10.1186/2191- 1991-3-6

[15] Koutsoyiannis, A. (1979). Modern Microeconomics. London: *Macmillan Education Ltd*

[16] McDonald, J. (2009). Using least squares and tobit in second stage DEA efficiency analyses. *European Journal of Operational Research*, 197(2), 792–798. doi:10.1016/j.ejor.2008.07.039

[17] Ng, Y. C. (2011). The productive efficiency of Chinese hospitals. *China Economic Review*, 22(3), 428–439. doi:10.1016/j.chieco.2011.06.001

[18] Nundoochan, A.(2020). Improving public hospital efficiency and fiscal space implications: the case of Mauritius, *International Journal for Equity in Health* ; doi.org/10.1186/s12939- 020-01262-9

[19] OMS (2021). 14ième Journée Mondiale de lutte contre le Paludisme au Bénin : Le Bénin s'engage pour un monde « Zéro Palu »

[20] OMS(2020). RAPPORT SUR LE PALUDISME DANS LE MONDE

[21] Ramalho, E. A., Ramalho, J. J. S., & Henriques, P. D. (2010). Fractional regression models for second stage DEA efficiency analyses. *Journal of Productivity Analysis*, 34(3), 239–255. doi:10.1007/s11123-010-0184-0

[22] Şahin, B., İlgün, G. and Sönmez, S. (2021), "Determining the factors affecting the technical efficiency scores of public hospitals using different regression methods",Benchmarking: *An International Journal*, Vol. 28 No. 7, pp. 2202-2215. https://doi.org/10.1108/BIJ-08

[23] SGSI/DPP/MS (2019). ANNUAIRE DES STATISTIQUES SANITAIRES ANNEE

[24] Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of Econometrics*, 136(1), 31-64. doi:10.1016/j.jeconom.2005.07.009

[25] Sultan, I. W. and Crispim, J.(2016). Evaluating the Productive Efficiency of Jordanian Public Hospitals, *International Journal of Business and Management*; Vol. 12, No. 1

[26] The DHS Program (2020). *Tendances des indicateurs du paludisme au Bénin : Résultats d'un atelier de l'utilisation des données des Enquêtes Démographiques et de Santé*. Rockville, Maryland, USA: The DHS Program