

Analysis of the Technical Efficiency of Public Hospitals in Togo: A non-Parametric Approach

By

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Abstract

Most health facilities in Togo are poorly equipped. Consequently, the rate of post-natal consultation remains low and varies between 9.5% and 39.4%. Barely half of all deliveries (47.1%) take place in health facilities. In this study, we analysed technical efficiency scores of 139 Togolese public hospitals over the period 2008–2010, and then identified the determinants of this efficiency. Double bootstrap data envelopment analysis was used to draw consistent inferences. We first estimated bootstrapped efficiency scores. Then, bootstrapped truncated regression was used to identify the determinants of public hospitals efficiency. The results indicate that, on average, small-sized hospitals (periphery care units) investigated, had the highest efficiency scores. The University Teaching Hospitals and regional hospitals which have significant material, human and financial resources were associated with lower efficiency. The most significant and robust factors of technical efficiency are per capita income, competition, hospital's balance, types of contract, and medical density. We found that income constraint and accessibility to health facilities are obstacles to efficiency. According to our results, we can infer that non-competitive public provision of health services is likely to be inefficient. Another important practical implication is that Togo must vigorously promote reform of the management system in public hospitals which regards corporate quality governance as the core. We hypothesize that if subsidies are allocated according to performance, they can positively affect efficiency. Policy makers should consider tying grant revenues to performance indicators.

Keywords: *Public hospitals, double Bootstrap, technical efficiency, governance, competition, Togo.*

1. Background

Numerous political speeches suggest that Togo is firmly committed to improving the health situation of its population by following guidelines from the World Health Organization (WHO), notably those related to primary health care, health and the environment, research, etc. However, despite all the policies implemented, healthcare services at public hospitals remains weak.

Importance of an analysis of hospital technical efficiency in Togo

An assessment of the state of health facilities conducted in Togo in 1995 showed that about 81% of them required simple renovation, rehabilitation or construction work (Ministry of Health, 2012). This state of affairs has not improved significantly; if anything, it has actually deteriorated. This situation is partly due to the financial constraints attributed to the political and economic crisis which Togo has experienced since 1990. These constraints have repercussions on the financial sector, provision of health care, distribution of human resources and demand for health care. Health statistics clearly show that the main services offered at the health facilities are underused. Indeed, the number of visits to hospitals has fallen drastically since 1990: from 60% in 1990, it fell to 31% in 2010 (Ministry of Health, 2012). The Ministry of Health (2009) reported a low rate of post-natal consultation in the whole country, varying from 9.5% to 39.4%. Nationwide, barely half (47.1%) of all children are born in hospitals (QUIBB, 2011). According to regions, assisted delivery rate varied from 37.1% in Lomé to 59.9% in the central region. The use of medical services is still low (12% in 2006 against 16% in 2011). Furthermore, we note an unequal distribution of medical and paramedical staff. The richest region (Lomé-Commune) in Togo contains approximately 83% of the medical and paramedical staff. Six other regions account for only 27% of the medical and paramedical staff.

Thus, the issue of maximum gain with limited resources must be a challenge for policy makers. Adequate policies and strategies would, for example, enable each hospital to produce a maximum quantity from available inputs. In the general context of inadequate funding, lack of medical staff and equipment, the goal of improving efficiency of public hospitals is essential for improving production and making health facilities more accessible. This study will, enable an assessment of the quality of relationship between health results achieved by hospitals and the amount of resources used. It will also enable

a classification of hospitals to identify which hospitals are particularly efficient and which ones are particularly inefficient in order to draw policy implications for the health sector.

Importance of examining public hospitals technical efficiency in Togo

Most of the Togolese population live below the poverty threshold. A household survey carried out in 2011 using the Core Welfare Indicators Questionnaire showed that the poverty incidence was 58.7% which would explain the higher prevalence of self-medication practices. According to QUIBB (2011), 61.8% and 71.4% of the individuals suffering from malaria and dental problems, respectively, opted for self-medication. This is the same for skins problems, diarrhoea, and respiratory problems, where individuals who opted for self-medication were estimated at 55.6%, 57.5%, and 64.6%, respectively.

These poverty figures mean that, generally, sick people in Togo prefer to self-medicate. They buy drugs sold in the street, which are often harmful to their health. At the same time, many of these people, especially in the rural areas turn to traditional healers. In connection to this, even though traditional medicine is recognized and regulated by the law and by the public health code in Togo, the treatment and medicines offered remain a great source of worry (WHO, 2009). Furthermore, wealthy individuals and those living in urban areas usually seek medical care from private hospitals. Since most Togolese people are poor, it is difficult for them to access private health facilities. In addition, data from most of private health facilities are unavailable (Ministry of Health, 2012).

The private health sector in Togo is characterized by non-observance of norms and standards in its functioning; unequal geographical distribution; expensive medical care; unavailability of data; and little involvement in the implementation of preventive programmes. In short, in view of the harmful consequences of self-medication and the concerns raised over traditional medicine, incentives should be offered to attract people to public hospitals.

A plethora of economic literature exists on the measurement of efficiency. However, despite the numerous empirical and theoretical studies done in various parts of the world, to the best of our knowledge little empirical study has been conducted in Togo. While some reports and studies are available regarding efficiency of public hospitals in the country, they are all descriptive. Thus, they do not help distinguish between efficient and inefficient hospitals, and to identify the determinants of this efficiency in order to guide the development of appropriate health policies.

2. Research objectives and hypothesis

The aim of this study was to evaluate the efficiency of public hospitals in Togo. The empirical exploration may yield some interesting insights that could interest regulators, Togolese policy makers, and also management of public institutions. This should provide useful policy information. The study further sought to assess whether there is a link between inefficiency levels and medical staff contracts and institution roles in the Togolese health system.

The objectives of this study were to:

- Analyse public hospitals technical efficiency scores.
- Evaluate if any relationship can be established between the efficiency and the public hospitals internal and external environmental factors.

The following two hypotheses were tested:

Hypothesis 1: Large and medium public hospitals are less efficient than small ones?

Gruca and Nath (2001) showed that in the community of Ontario, hospitals of small sizes are more efficient than those of big sizes.

Hypothesis 2: Location, medical staff contract, and average income of the population have a significant effect on technical efficiency.

Roh et al (2013) showed that rural hospitals are more efficient than urban hospitals in Tennessee.

The rest of this paper consists of the following three parts: the first part is an overview of Togo's public hospital organization and methodology; the second describes data and variables, and the third reports the analysis and results.

3. Overview of Togo's public hospital organization

In accordance with the framework for health development recommended by WHO (2000), the health system in Togo is pyramidal with three levels: central, intermediate and peripheral.

The base of the pyramid that represents the peripheral level or the operational level is organized into 35 health districts (Ministry of Health, 2009). This peripheral level is responsible for the planning, implementation, monitoring and evaluation of health sector policy. This level is also responsible for mobilizing communities and local stakeholders, including traditional practitioners. The middle of the pyramid represents the intermediate or regional level and corresponds to six health regions. Finally, the top of the pyramid, commonly called central or national level, comprises the office of the minister of health and its central directorates. .

In 2009, the distribution of health facilities (Ministry of Health, 2009), according to the health pyramid was:

- The first level represented by the maternal and infant protection centres (PMI) and peripheral care units (USP) accounted for 395 USP and 15 PMI.
- The second level represented by the district hospitals (HD or HP) were 25, to which 1 specialized hospital (HS) was added
- The regional hospital centres (CHR), six in total, and the university hospital centres (CHU), three in all, constitute the third level.

To all these centres are added:

- At the central level, the National Centre for Blood Transfusion (CNTS) and the National Institute for Hygiene (INH), which is the national referral laboratory
- At the regional level, the regional centres for blood transfusion
- At the peripheral level, 64 social medical centres (CMS) and polyclinics (Poly)

The referral hospitals (CHU, CHR) have a threefold mission:

- Provision of curative, preventive and promotional health care

- Ongoing training of staff and students, and health education
- Applied health research activities

In each referral hospital, the technical service comprises six departments: internal medicine and medical specialties; surgery and surgical specialties; paediatrics and paediatric specialty; gynaecology and obstetrics; pulmonary and infectious diseases; services for diagnostics (Laboratories, radiology department, pharmacy); and biomedical maintenance services.

The Peripherals Care Units (USP) are the first level of care and usually the only link maintained by rural people with a healthcare provider recognized by the state. These units are designed for a population of between 5,000 and 15,000 people. They usually have five beds, four of which are for maternity services. Generally, it is a single building for curative care, family planning, maternity, and pharmacy services.

The Social Medical Centres (CMS) and Polyclinics (Poly) are placed under the direction of a physician. They are designed for a population of over 15,000 people with an average of 16 beds for curative and maternity care. The layout of the space is intended for healthcare services. However, an additional block for family planning (FP) and maternity is available. In addition, each centre has a laboratory, a pharmacy, and a unit for observation of patients. Officially, the staff comprise a physician, a nurse (including a state registered nurse), an auxiliary reserve, a midwife, a laboratory technician and one auxiliary midwife.

The Togolese public health system comprises large hospitals (CHU, CHR) and smaller ones (USP). The two types of hospitals use the same categories of inputs and offer identical outputs, except for the number of hospitalized people at the small hospitals. The small hospitals are actually not authorized to hospitalize patients, precisely because they are too small to offer such services. They are required to transfer people to large hospitals for inpatient care. Among the large hospitals are university hospitals (*CHU*), regional hospitals (*CHR*) and district hospitals (*HD or HP*).

4. Methodology

Compared with other industries, measuring efficiency in the health sector is complicated by characteristics specific to health and health services (Ozcan, 2008). Measuring efficiency requires a conceptual framework with which to specify the production process; identify the determinants of performance; and derive efficiency measures in terms of well-defined variables. Healthcare managers must adapt new methods to use the resources at their disposal in order to achieve high performance, namely effective and high quality medical outcomes (Ozcan, 2008).

The 1980s brought many challenges to hospitals as they attempted to improve the efficiency in healthcare delivery. Efficiency has become one of the most attractive work areas of healthcare management literature. Studies on hospital efficiency mostly focus on the issue of maximum gain with limited resources (Sarkis and Talluri, 2002). The interest in hospital efficiency has increased because of the desire to control increasing costs. Accordingly, hospital resources and their processes became critical and, as a result, the number of studies has increased (Bakar et al, 2009).

Recent literature (Briec and Peypoch, 2010) on the microeconomic measurement of the productive performance of firms shows that, performance, as in other service industries, can be defined as an appropriate combination of efficiency and effectiveness. Farrell (1957) extended the work of Debreu (1951) and Koopmans (1951) to define a simple measure of firm efficiency, which accounts for multiple outputs. He defined efficiency as comprising two components, namely: technical efficiency and allocative efficiency. *Technical efficiency* reflects the ability of a firm to obtain maximal output from a given set of inputs. *Allocative efficiency* reflects a firm's ability to use the inputs in optimal proportions, given their respective prices and the production technology.

Existing literature suggests that technical efficiency is more prevalent in the health system. Thus, there are several indicators of productive performance, one of which is technical efficiency. Efficient care, therefore, means that a healthcare facility produces a given level of care or quantity that meets an acceptable standard of quality, using the minimum combination of resources (Ozcan, 2008). Each healthcare organization, service and/or procedure must be examined individually. In some areas, the organization may have to increase the inputs used to improve quality. In other areas more must be done with fewer resources while holding quality constant. Healthcare managers will always be challenged with one of the most difficult tasks, determining the proper mix of inputs and outputs (Ozcan, 2008).

Two categories of methods are traditionally used to estimate efficiency of health facilities. These are parametric and non-parametric methods. Most healthcare studies

have analysed efficiency of health facilities using a non-parametric method called Data Envelopment Analysis (DEA) (Nedelea et al, 2010). The DEA method is by far the most common method for analysing efficiency in health care (Hollingsworth and Peacock, 1999).

Despite its numerous advantages, DEA has some drawbacks (Simar and Wilson, 1998; Simar and Wilson, 2000; Simar and Wilson, 2007; Greene, 2008). DEA efficiency scores are biased and serially correlated (Simar and Wilson, 2007). Therefore the inferences in two-stage approaches are invalid (Simar and Wilson, 2007). Simar and Wilson (2007) propose a double bootstrap method that enables researchers to correct for serial correlation, measurement error, and to simulate a true sampling distribution by mimicking the data generating process (Latruffe et al, 2008).

The procedure used in this study follows that of Simar and Wilson (2007) Algorithm 2, which comprises seven steps.

Double bootstrap approach

First, in the Togolese context characterized as it is by an inadequate budget and a shortage of staff and equipment, it would be inappropriate to seek to minimize inputs instead of seeking to improve outcomes. In such conditions, an output-oriented choice would be more suitable to the extent that the pursued goal is not to reduce the resources but to increase health outputs. So, the seven steps of the double bootstrap algorithm 2 are:

1. A DEA output-orientated efficiency score is calculated for each hospital by solving the following variable return to scale (VRS) programme:

$$\max_{\lambda, \delta_i} \delta_i$$

$$\text{Under constraint } -\delta_i y_i + Y\lambda$$

$$x_i - X\lambda$$

$$N1'\lambda = 1$$

Where y_i and x_i are respectively the original output and input matrices of the i^{th} hospital; Y and X are respectively the original output and input matrices of the sample; λ is a $n \times 1$ vector of constants. $1 \leq \delta_i \leq \infty$ is the proportional increase in output that could be achieved by i^{th} hospital with the constant input quantities. Hospital with scores above 1 are deemed inefficient.

Then, let us assume that the efficiencies scores depend on environmental variables z_i .

2. Maximum likelihood is used in the truncated regression of $\hat{\delta}_i$ on z_i to provide an estimate $\hat{\beta}$ of β and an estimate $\hat{\sigma}_\varepsilon$ of σ_ε .

3. For each hospital $i = 1, \dots, n$ the next four steps (a–d) are repeated B_1 times to yield a set of B_1 bootstrap estimates

a) ε_i is draw from the distribution with left-truncation at $(1 - \hat{\beta}z_i)$

b) $\delta_i^* = \hat{\beta}z_i + \varepsilon_i$ is computed

c) A pseudo data set (x_i^*, y_i^*) is constructed, where $x_i^* = x_i$ and $y_i^* = y_i \delta_i / \delta_i^*$

d) A new DEA estimate $\hat{\delta}_i^*$ is computed on the set of pseudo data (x_i^*, y_i^*)

c) For each hospital $i = 1, \dots, n$ the bias-corrected estimator $\hat{\hat{\delta}}_i$ is computed:

$$\hat{\hat{\delta}}_i = \hat{\delta}_i - \text{biás}_i$$

where biás_i is the bootstrap estimator (Simar and Wilson, 2007) of bias obtained as:

$$\text{biás}_i = \left(\frac{1}{B_1} \sum_{b=1}^{B_1} \hat{\delta}_{i,b}^* \right) - \hat{\delta}_i$$

5. Maximum likelihood is used in the truncated regression of $\hat{\hat{\delta}}_i$ on z_i to provide an estimate of $\hat{\hat{\beta}}$ of β and $\hat{\hat{\sigma}}$ of σ_ε .

6. The next three steps (a–c) are repeated B_2 times to yield a set of B_2 bootstrap

estimates

a) For each hospital $i = 1, \dots, n$, is drawn from the $N(0, \hat{\sigma})$ distribution with left truncation at $(1 - \hat{\beta}z_i)$

b) For each hospital, $\delta_i^{**} = \hat{\beta}z_i + \hat{\varepsilon}_i$ is computed.

c) Maximum likelihood is used in the truncated regression of δ_i^{**} on z_i to provide an estimate $\hat{\beta}^*$ of $\hat{\beta}$ and an estimate of $\hat{\beta}$.

7. Confidence intervals are constructed. The estimated $(1 - \alpha)$ per cent confidence interval of the j^{th} element β_j of the vector β is:

$$\text{Prob}(\text{Lower}_{\alpha,j} \leq B_j \leq \text{Upper}_{\alpha,j}) = 1 - \alpha$$

Where $\text{Lower}_{\alpha,j}$ and $\text{Upper}_{\alpha,j}$ are calculated using the empirical intervals:

$$\text{Prob}(-\hat{b}_\alpha \leq \hat{\beta}_j^* - \hat{\beta}_j \leq -\hat{a}_\alpha) \approx 1 - \alpha$$

$$\text{Where } \text{Upper}_{\alpha,j} = \hat{\beta}_j + \hat{b}_\alpha$$

$$\text{Lower}_{\alpha,j} = \hat{\beta}_j - \hat{b}_\alpha$$

Following Simar and Wilson (2007), the results of steps 1 to 4 of Algorithm 2 were obtained from 2,000 bootstrap iterations, running the software package Frontier Efficiency Analysis with R (FEAR 2.0.1.) of Wilson (2013). The second step (steps 5

to 7 of algorithm 2) that consists of regressing the bias-corrected technical inefficiency scores on a set of explanatory variables was performed using STATA 13 (Lépine et al, 2015).

Inputs and outputs

Inputs

Inputs are, as in any economic analysis, capital and labour. Labour factors can be classified in several categories. Certain authors consider only two categories: doctors and other staff (Eakin, 1991) or nurses and other staffs (Folland and Hofler, 2001). Others consider three categories: academic staff, nursing staff and administrative staff (Steinmann and Zweifel, 2003). Another group considers four categories: medical staff, nurses, other health workers and administrative staff (Scuffham et al, 1996).

In this study, the labour factor comprises: (i) medical staff—all the medical doctors of all grades; (ii) paramedical staff—all the nurses and midwives; (iii) technical staff—the laboratory technicians, their assistants, the resuscitators and anaesthetists; and (iv) administrative staff—all those in charge of the administrative and financial management of the hospital.

With regard to capital factor, Ozcan and Luke (1993) showed that one can estimate capital investments in a hospital using two indicators: (1) plant size, measured by number of operational beds, and (2) plant complexity, measured using number of diagnostic and special services provided exclusively by the hospital. In the absence of specific data on the technical wherewithal, the capital factor is estimated in this study by the number of operational beds available at the health facilities (Dukhan, 2010; Grosskopf and Valdmanis, 1987; Ozcan and Luke, 1993; Dervaux et al, 1997; Linna, 1998; Hollingsworth, 2003; Tiehi, 2006; Audibert et al, 2008; Pham, 2011).

Outputs

With regards to outputs, we need to use appropriate measurements to account for each type of service in the hospital service production. Because all patients arriving at the hospital do not receive the same level of care and service, severity of admissions or hospitalization (case-mix indexed) is commonly used (Ozcan, 2008). According to Ozcan (2008), the case-mix indexed is calculated based on patient diagnostic related groups (DRGs) providing relative weight for acuity of the services provided by a hospital. Depending on availability of data, certain authors used DRG-weighted number of admissions as the hospital's main output (Linna, 1998; Rosko, 2001; Heshmati, 2002). Other studies have considered unadjusted number of cases in several departments as multiple outputs (Vita, 1990; Eakin, 1991; Steinmann and Zweifel, 2003). Others consider factors such as DRG-weighted number of admissions of hospitalization are exogenous to the hospital, and suggested factors such as percentage of board-certified physicians and doctor or nets per bed (Farsi and Filippini, 2005). Folland and Hofler (2001) have

considered percentage of board certified physicians and a measure of bed availability as hospitals main outputs.

Due to lack of data, in the Togolese context we used as outputs: number of people hospitalized weighted by the degree of severity of their illnesses (Leleu and Dervaux, 1997; Linna, 1998); number of admissions to hospitals—which represents all individuals who have sought consultation from the hospital during the year (Audibert et al, 2003); number of surgical operations (Audibert et al, 2003; Audibert et al, 2008); total number of birth deliveries (Audibert, et al. , 2003); and total number of pregnant women seen during prenatal consultations.

Number of children born and women seeking prenatal consultations are indicators referring to the United Nations Millennium Development Goals (MDGs) 4 and 5. About 20% of the deaths of children aged under 5 years happen during the first week after birth and can be attributed to child malnutrition and no or too little prenatal care (UNICEF, 2009). This is why prenatal consultations and medically-assisted births are key indicators of infant survival and maternal mortality. Table 1 presents bootstrap DEA models analysed.

Table 1: The DEA model analysed

Models (type of hospitals)	Inputs	Outputs
USP (Peripheral Healthcare Units)	Medical staff, paramedical staff, technical staff, administrative staff, number of beds	Admission, births delivered, prenatal consultations
CHU, CHR, and HD	Medical staff, paramedical staff, technical staff, administrative staff, number of beds	Admissions, number of people hospitalized weighted by the degree of severity, number of surgical operations, births delivered, prenatal consultations

Referring to Table 1, the efficiency scores were calculated for two distinct groups of hospitals. These scores were calculated based on the hospitals' similarity in terms of their missions, equipment, and environment. USP are not authorized to hospitalize patients. They are supposed to transfer people requiring hospitalization and serious cases to hospitals with high-technology medical equipment, notably CHU, CHR, and HD. Likewise, surgeries, paediatrics specialization, pulmonary and infectious diseases, radiology, laboratories analysis, gynaecology and obstetrics, etc. are also performed at CHU, CHR and HD levels. Thus, we first calculated the efficiency scores of the 111 USPs. Second, we calculated the efficiency scores of the 28 hospitals providing hospitalization and surgical services (CHU, CHR and HD).

Number of people hospitalized weighted by the degree of severity of their illnesses

The average length of stay (ALOS) of patients is an important variable at the heart of the new delivery systems in healthcare facilities. The length of stay is an indicator of productivity and good organization. Unlike the system of block grants, where budgets for hospitals were renewed from year to year compared with the budget of the previous year, with the Alma Ata conference (1978), hospital activities now account for a large share of hospital resources.

The level of the ALOS uses two key indicators of hospital performance: number of hospitalization days (NJH) and number of hospitalized patients (NH). The ALOS was higher in health facilities which were associated with a high level of NJH and a low-level of NH. This is because these hospitals treat severe diseases and take care of the patients until their death or recovery. Under these conditions, bed management causes a reduction in hospitalizations corresponding to a high level of ALOS. A high level of ALOS is thus associated with high mortality.

The ALOS is lower in health facilities associated with a low level of NJH and a high level of NH. Under the pretext of reducing their ALOS, some institutions may seek to increase their productivity and increase their revenue by releasing patients earlier to stimulate new hospitalizations for the same patient on subsequent days.

If more serious cases are treated, weight given to hospitalizations should be high. A positive relationship is thus deduced between the hospital mortality, the ALOS and the weight of hospitalizations (w) (Dervaux et al, 1997; Linna, 1998).

$$W = f(\text{ALOS}(+) \text{ Mortality rate}(+))$$

$$W = \frac{\overline{\text{ALOS}}}{1 - d} \text{ with } d \text{ the mortality rate.}$$

Number of hospital days (NJH), number of hospitalizations (NH), ALOS and mortality rate (d) in each hospital were estimated from data from the top 10 causes of hospitalization and death.

Explanatory variables

Designing appropriate health policies to improve efficiency of hospitals cannot be done without the knowledge and the study of key determinants of technical efficiency. Consequently, the second stage of this research consists of establishing a link between the inefficiency and its determinants, which include internal environmental factors (i.e., characteristics that are specific to the hospital) and external ones.

Financial factors

A review of public hospitals' accounts shows that there is a surplus or deficits of budgets (operating and investment). Any deficit is financed either by the hospital reserves or by the ordinary grants from government, region, municipality or district. Audibert et al (2003) argued that when directors or managers of a hospital know that the municipality or district, that has other priorities, is unable to help the hospital, they will manage the hospital more efficiently. A deficit balance is a financial constraint which can foster, in the course of the year, the use of income-generating strategies with a positive impact on efficiency (Rosko and Chilingirian, 1999; Audibert et al, 2008).

Three indicators are used to measure the financial constraints: (i) the balance (percentage of expenditure) of the hospital; (ii) the share of grants received from different administrative levels in the non-staff costs; and (iii) the implementation of the integrated management system. Since hospitals manage revenues from the sale of drugs, this study referred to the balance between the hospital's receipts and expenses.

Environmental factors

The demographic environment through population density has a considerable influence on hospital curative activities. As a demographic variable, the literature often retains the *size of the municipality* or the locality population.

Hao et al (1997) consider that per capita income should be one of the main determinants of technical efficiency. In the case of China, for example, Hao et al (1997) showed that the demand for certain care is influenced by the income. There exists a positive relationship between per capita income and hospital medical activities (Audibert et al, 2008).

Specific characteristics of the hospitals

The ratio of the medical staff to the hospital's total staff is used to appreciate the importance of purely medical activities compared with the other activities of the hospital (administration, logistics, medico-technical activities, etc.) (Tiehi, 2006).

The preventive and curative care are an integral part of a hospital's mission, particularly for municipal hospitals. The preventive activities are often neglected because of lack of financial resources. The existence of certain complementarity between these two activities is often needed in the literature. The preventive care may be instrumented in order to drain patients in the hospital. Two indexes are often mentioned: the number of families visited and the number of administrated vaccines.

In addition to the above traditional factors, we can mention others that are not less important such as the distance covered, competition, corruption, governance, etc.

The geographic distance covered by patients to reach the hospital is also a factor explaining efficiency of hospitals (Worthington, 2004).

Market structure could also influence efficiency of hospitals. Facing different degrees of competition in the market, the hospitals will have different incentives to alter their behaviour. There may be more efficiency in less concentrated markets. Rosko and

Chilingirian (1999) found that efficiency is positively related to market concentration. The extent of consolidation of the local hospital market was measured in terms of the Herfindahl-Hirschman Index (HHI), the standard measure used in economic analyses of market competition (Robinson, 2011). We measured market structure using HHI as an index of hospital market structure. Many studies have used the HHI concentration index to evaluate the impact of competition on technical efficiency of health institutions. Referring to Burgess and Wilson (1998) and Puenpatom and Rosenman (2008), three types of results emerge: the competition tends to improve the health institution efficiency; the competition may have the inverse sign with efficiency; and the competition has no significant effect on the efficiency of health institutions. Chua et al (2011) studied the link between competition and technical efficiency of public hospitals in Victoria State, Australia, and found a positive relationship between efficiency and competition as measured by HHI. Kessler and McClellan (2000) looked at the impact of hospital competition in the US and found that in the 1980s, the impact of competition was ambiguous, but in the 1990s, higher competition led to lower mortality. Cellini et al (2000) showed that competition is not a value per se and that its effects on the performance of the system are affected by the rules governing it. In the Togolese context, the question was whether competition could improve public hospitals' efficiency.

Corruption may also decrease efficiency of hospitals particularly public hospitals. One of the key constraints to performance level of the health institutions in developing countries is poor management in the public sector, particularly at district and municipality levels (Mills et al, 2006). WHO (2010) estimates that 10% to 25% of public health expenditure on provision of medicines, in term of materials and infrastructure is lost each year through corruption.

Governance looks at human and physical resources management, provision and use of medicine, and size and range of institution activities. Reductions in efficiency of hospitals due to inefficient management of labour are important. For example, in Tanzania, Olivier-Cruz et al (2003) demonstrated that non-reasonable absence and the time taken in rest, in social contract and to reach patients decreased technical efficiency levels by 26%. Issakov (1994) estimated that at least 50% of medical material from health institutions in developing countries was partially usable or totally unusable. In sub-Saharan Africa, up to 70% of medical material is unused. Research on this systemic issue found that unusable material is explained by bad management during technologies acquisition; lack of training of users; and lack of efficient technical assistance (WHO, 2010). In 10 low and middle-income countries only, 55% of beds were occupied on average in 2007 (Chisholm and Evans, 2010).

About the *degree of specialization*, Chilingirian (1993) found that the more specialized health institutions are associated with the low technical efficiency in the use of resources.

To these factors mentioned above, two other factors are rarely reported in the analysis of the determinants of technical efficiency that we consider crucial in the African context and more particularly in Togo. These concern the *medical staff remunerations and medical density*. Grignon et al (2002) argue that the payment system of medical staff is a real strategic choice and there is no "natural" pattern of payment. In the Togolese context characterized by the principle that doctors are not paid based on their committed resources or "effort", the risk exists that doctors could provide too few services (consultations,

examinations), and too little intangible resources (shorter consultations, less attention) to the patient.

The technical efficiency of the hospitals located in municipalities or small districts could result either from the fact that the entire demand is met either because of high medical density: we talk about *supply shock*. *The medical density* is an indicator that measures, for example, for general practitioners (or specialists), the number of general practitioners (or specialists) per 100,000 inhabitants, per department and per year. At the hospital level, this indicator can be seen, for example, as the number of general practitioners per 100,000 inhabitants per district per year. Medical density is used in a public system (public hospitals) as a measure of supply shocks experienced by the doctor or hospital in its area of activity. These supply shocks could in the case of public hospitals significantly influence the activity of medical staff and indirectly have an impact on technical efficiency.

Table 2: Definition of exogenous variables

Variables	Definitions
Per capita income	Per capita income is a qualitative variable with 3 modalities. In the Poverty Reduction Strategic Paper (IMF, 2010), different regions and prefectures of Togo were mapped according to the profile of income poverty. According to this map, there are in each region and prefecture, low-income areas, middle-income areas and high-income ones. Depending on the location of the hospitals of the sample, the mapping of poverty in Togo has allowed us to identify hospitals located in areas with low per capita income (0), in areas with average per capita income (1) in areas with high per capita income (2).
Competition (HHI)	It is calculated as the sum of squared market shares of each hospital. Market share is the ratio of a hospital's beds on the total number of beds in the region (Robinson, 2011). Low HHI means that competition has little effect on the hospital.
Medical density	3 types of medical density were defined: number of doctors divided by the population of the area where the hospital is located number of paramedics divided by the population of the area where the hospital is located number of technical staff divided by the population of the area where the hospital is located
Medical staff sign on the general budget	Total number of medical staff at the hospital hired by the State
Medical staff sign on the autonomous budget	Total number of medical personnel of the hospital recruited by the hospital management. This is the total number of medical personnel paid from the revenues of the hospital.
Hospital's balance	Hospital's balance = Revenue minus expenses*
Population of district	Population of the area where the hospital is located.

Source: Author

5. Hospitals of the sample and sources of data

This study examined a sample of 139 hospitals, among which were three university hospitals (CHU), six regional hospitals (CHR), 19 District hospitals (HD or HP), 12 CMS and polyclinics, and 99 periphery care units (USP). Table 3 provides the representativeness of the components of the sample, referring to the number of hospitals existing in Togo in 2009.

Table 3: Representativeness of the components of the sample

Health facilities	In the sample	Population	Proportion (%)
CHU	3	3	100
CHR	6	6	100
HD or HP	19	25	76
CMS + Polyclinics (Poly)	12	64	18.75
USP	99	395	25.06

Source: Author

Table 3 shows that this study considered all the large hospitals (100% of CHU and CHR) and just over three-quarters (76%) of the medium-sized hospitals in the country.

However, there could be a problem of representativeness of smaller hospitals. The representation of CMS and USP is low (approximately 19% and 25% of the study population, respectively). When some constraints prevent getting the optimal number of observations that should be part of the sample (it may be possible that the size of the sample is smaller or bigger than the required one), the decrease or increase of projected size will affect the accuracy of the estimation and therefore the confidence interval (ACF, 2011). To find the level of accuracy from the sample size, the mathematical formulas used to calculate the size are reversed (ACF, 2011).

(i) *Simplified formula*

$$N = \frac{N}{1 + N + \acute{e}^2} \Rightarrow e = \sqrt{\frac{N - n}{N * n}}$$

Where N is the size of the population, e is the level of precision and n the sample size.

In the specific case of small hospitals (USP):

$$e = \sqrt{\frac{395 - 9}{395 * 9}} = 0.087$$

(ii) *Formula for the proportions*

$$n = \frac{t^2 * p * (1 - p)}{e^2} \Rightarrow e = \sqrt{\frac{t^2 * p * (1 - p)}{n}}$$

Where e = level of accuracy; p = degree of variability (proportion of hospitals with reliable data); and t = typical value associated with the required level of confidence (95% \geq 1.96).

$$e = \sqrt{\frac{1.95^2 * 0.2506 * 0.7494}{9}} = 0.0853$$

Where $p=25.06\%=0.0853$

Since we are forced to reduce the size of the sample at 99, we lose in precision: (+/- \prec 8.7% \prec 10%).

For all the surveyed hospitals, the level of accuracy is:

$$e = \sqrt{\frac{1.96^2 * 0.2819 * 0.718}{139}} = 0.075$$

Where $p = \frac{139}{493} = 0.2819$

For all hospitals investigated, we also lose in precision: (+/- 5% \prec 7.5% \prec 10%).

The data were compiled in 2011. With support from the Ministry of Health, the study used annual reports of health activities in 2008, 2009 and 2010 for all the 493 hospitals in Togo. These reports included all data related to hospital activities (inputs and outputs). However, to build the sample and examine the reliability of the data available in the reports, five teams visited all hospitals at the end of 2010. For this purpose, we obtained official authorization from the Minister of Health for access to all hospitals. Interviews were conducted with the heads of staff, hospital leaders, doctors, and administrative staff. They answered questions about the number of medical, paramedical, and technical staff. We also counted the number of functional beds at these hospitals and identified technical medical equipment available. It was difficult to determine the reason for absences (they were either on site visits or on mission). This is one of the limitations of this study.

In the second step, we compared data collected in the field with data available in the reports for each hospital in 2010. Surprisingly, there was a gap between data in the reports and those we collected. Only 139 hospitals out of 493 (28.19%) presented nearly identical data to those collected on the field data in 2010. For this reason, our study focused on these 139 hospitals. We needed data such as revenue, expenses and rate of vaccination coverage etc. available in the reports and felt that only these hospitals would provide accurate data. We therefore extracted the relevant information on the health activities of these 139 hospitals from the annual reports provided by the Ministry of Health (2008, 2009 and 2010).

6. Results and analysis

First, we present descriptive statistics of variables. Empirical results are presented and analysed in a second step.

Descriptive statistics of variable

Statistics related to medical density are presented in Table 4. In 2010, the hospitals in the sample had at their disposal, an average of six medical staff per 100,000 inhabitants, 69 paramedical for 100,000 inhabitants, and 13 technical staff for 100 000 inhabitants. However, it is important to note the high dispersion of medical staff repartition by type of hospitals. The small size hospitals (USP, CMS, and poly) had an average of less than one doctor for 100,000 inhabitants whereas large hospitals (CHU, CHR, and HD or HP) had respectively about 11, seven, and 37 doctors, respectively for 100,000 inhabitants on average. A high density in terms of paramedical staff, respectively, is seen in the USP (Table 5). USP and CMS, CHU, CHR, and HP respectively had an average of 64, 36, 60, and 104 paramedical staff for 100,000 inhabitants. It is interesting to look into whether a supply shock would increase the technical efficiency of public hospitals.

Table 4: Medical density by categories of hospitals

	Medical staff			Paramedical staff			Technical staff				
	Mean	Std dev	Max	Mean	Std dev	Max	Mean	Std dev	Max		
CHU	10.56	5.40	16	35.89	22.22	13.67	58.11	32.87	11.40	21.47	44.27
CHR	6.57	8.22	2.00	60.73	82.38	21.16	143.11	29.47	36.55	7.08	66.02
HD or HP	36.74	42.30	5.56	103.94	69.45	34.49	173.39	30.63	29.58	1.05	60.21
USP+CMS+Poly	0.65	4.85	0.00	64.64	141.74	77.10	205.39	8.91	34.88	0.12	43.79
Sample	6.05	20.48	0.00	69.22	131.20	61.98	200.42	13.29	35.04	0.12	66.02

Source: Author

Statistics related to the staff recruited on the autonomous budget and those recruited on the general budget are presented in Table 5.

Table 5: Number of medical staff by type of contract

	staff sign on the general budget (pbg)			staff sign on the autonomous budget (Pba)		
	Mean	Std dev	Max	Mean	Std dev	Max
CHU	270(38.35%)	161.75	108	434(61.65%)	271.85	162
CHR	76(38%)	48.14	28	115(62%)	41.95	73
HD or HP	89(37.71%)	94.35	05	147(62.29%)	170.71	98
Sample	106(38.27%)	112.31	05	171(61.73%)	191.18	98

Source: Author

On average, the public hospitals accounted for more staff recruited on the autonomous budget than those recruited on the general budget. On average, just under two-thirds (61.73%) of medical staff of hospitals are recruited on the autonomous budget; those recruited on the general budget represented only 38.27% of the medical staff. This trend was also observed in different categories of hospitals. As an example, by referring to the health activities report, 64.09% of staff of CHU campus was paid on autonomous budget.

Competition was low within the public hospitals. The more the index tends to 1, the more the competition increased. The results in Table 6 reveal that competition was almost absent at USP, CMS, and HP or HD levels. It was low in CHR and CHU. This low competition within public hospitals does not explain the observed level of technical performance in these institutions.

Table 6: The competition (Herfindahl-Hirschman Index)

	HHI		Min	Max
	Mean	Std devi		
CHU	0.312	0.211	0.101	0.523
CHR	0.255	0.177	0.078	0.432
HD or HP	0.087	0.058	0.029	0.145
USP+CMS+Poly	0.007	0.006	0.001	0.013
Sample	0.0372	0.086	0.048	0.123

Source: Author

Empirical results

Bias corrected technical efficiency scores

Bias corrected technical efficiency scores were estimated year by year, with different frontiers. Thus, no comparison was made between the scores obtained in 2008, 2009 and 2010. Tables 7 summarizes the results.

Table 7: Hospital bias corrected efficiency scores

	USP (periphery healthcare units)		CHU, CHR, and HD	
	Scores	Number of efficiency hospitals (%)	Scores	Number of efficiency hospitals (%)
2010	1.218	37 (33.33)	1.902	5 (17.85)
2009	1.078	23 (20.72)	2.07	5 (17.85)
2008	2.248	16 (14.41)	3.417	8 (28.57)

Source: Author

From the results in Table 7, it is possible to conclude that, on average, the public hospitals investigated were technically inefficient. For large and medium-sized hospitals, the inefficiency scores of 1.902, 2.07, 3.417 indicates that, on average, the hospitals could increase their output by 90.2%; 107% and 241.7% in 2010, 2009, and 2008, respectively,

using the same level of resources. Only five of large and medium-sized hospitals out of 28 used their resources efficiently in 2010. In other words, 82.15% of these hospitals were technically inefficient in 2010. These results corroborate those of other works done in sub-Saharan Africa. Indeed, Masiye et al (2002) analysed the technical efficiency of 20 hospitals in Zambia and found that 75% of them were technically inefficient. In addition, a study of 155 primary care clinics in South Africa found that 70% of them were technically inefficient (Kirigia et al, 1999).

Table 7 shows that the inefficiency scores clearly indicate that small-sized hospitals (periphery care units) investigated, on average, had the highest efficiency scores. However, these results should be analysed with precaution.

The university hospital (CHU), regional hospitals (CHR) and district hospitals (HD) which have significant material, human and financial resources were associated with lower efficiency. Moreover, Togolese health facilities are not homogeneous and do not have the same productive capacity. The highest mortality rates were found in large hospitals (CHU) with a high-technology medical equipment. For example, in 2009 the University Hospital Sylvanus Olympio recorded the highest ALOS in Department of Traumatology. The patients stayed, on average, a month in hospital. This was due to the closure of four operating theatres for refitting, and patients lacking the resources to acquire the surgical materials (medical implants and prosthetics). The increase in mortality rate recorded in the intensive care department in this hospital was related to late admission of patients; late transfer of patients who were already terminal; lack of financial resources to buy pharmaceutical products; and lack of qualified personnel. The mortality rate was also high at CHU Kara in 2010. The main cause was the delay in the evacuation of patients from the peripherals facilities to the CHU. Furthermore, the hospital lacked specialized services such as cardiology, neurology, paediatric surgery, etc.

Thus, several reasons could explain the level of inefficiency of the large hospitals. This would be the lack of specialists; most patients being too poor to afford the services; the admission of patients in poor health condition; late transfer of patients from other facilities; and lack of equipment and medicines for first aid.

Low efficiency scores could have been due to higher quality of care provided or low patient health status (referral facilities tend to keep their patients until their recovery or death). These results suggest the need for specialized services in referral hospitals such as cardiology, neurology and paediatric surgery. This should be accompanied by availing and repairing the equipment and the establishing a mechanism for to improve the capacities of physicians and specialized medical staff. The heads of peripherals care units, private hospitals, and traditional healers should be sensitized on the negative consequences of late transfers of patients to referral facilities. In particular, sanctions should be taken against private hospitals and traditional healers if these unfortunate events repeatedly occur.

Moreover, the dispersion of the technical efficiency scores could also be explained by the level of sample accuracy that is greater than 5% (about 7.5%). A more representative sample would lead to more robust results.

Determinants of hospitals inefficiency

Referring to the results in Table 8, the per capita income positively influences efficiency

of small-sized public hospitals. Our results are in line with those obtained by Hao et al (1997) who found that per capita income was the main determinant of technical efficiency in poor rural China. In Togo, the low level of income encourages population to opt for self-medication, especially in rural areas. A total of 61.8% and 71.4% of the suffering individuals respectively from malaria and dental problems opted for self-medication in 2011. The same applied for diarrhoea and respiratory problems where the individuals who were self-medicating were respectively estimated at 57.5% and 64.6%. An improvement in the population's purchasing power would lead to an increase in attendance at health facilities. Since people have to pay for health care, an improvement in per capita income should allow patients to access expensive care. In addition, in rural areas, where most of the small-sized hospitals are located, accessibility and cost of treatment determine if patients will seek health care. These results suggest that universal health coverage could help address accessibility problems. The National Health Insurance Scheme (NHIS) managed by the National Institute of Health Insurance (INAM) is a mandatory health insurance which covers civil servants, civil servant retirees, and up to five dependents—spouse and four children aged 21 or under. Coverage of the private and informal sectors through NHIS has not begun yet. It covers only about 3.5% of the Togolese total population.

Variables such as density of medical staff, paramedical staff, and technical staff have positive and significant impact on technical efficiency. In the context of Togo, where there is a significant lack of medical and technical staff, a positive impact on health supply would lead to an increase of modern healthcare consumption.

Table 8: Bootstrap with 2,000 replications

Variables	USP (periphery healthcare units)	CHU, CHR, and HD
	Coefficients	Coefficients
Per capita income	-0.074*** (-11.7)	-0.022 (-0.15)
The hospital's balance	-0.004** (-2.51)	-0.0054*** (-3.22)
Medical density (medical staff)	- 0.765*** (-3.44)	-0.072** (-2.07)
Medical density (paramedical staff)	- 0.004** (-2.51)	0.020 (0.75)
Medical density (technical staff)	- 0.0926*** (-6.41)	-4.85** (-2.27)
Competition	-0.071** (-2.11)	-0.041*** (-3.88)
pbg		-1.423*** (-7.06)
pba		- 0.003 *** (-3.07)
Population of district	0.071 (0.95)	0.052 (0.70)

Notes: *** (**) (*) Significance level at 1%, 5% and 10%.

Table 8 shows the effect of competition, per capita income and contract types on inefficiency of hospitals in larger and medium-sized hospitals. The results show that per capita income does not influence the large and medium hospitals located in environments where people have high and intermediate incomes. In urban areas, care quality (satisfaction) increases the likelihood of using a public health facility. Patients often ask questions to determine why they should pay more, if they would be unsatisfied. In urban areas, the physicians favour the private sector to the detriment of public sector. These results highlight the establishment of a healthcare quality monitoring system in public health facilities.

The medical staff recruited on the autonomous budget and those recruited on the general budget have a significantly positive influence on technical efficiency. However, it is noteworthy that staff recruited on the general budget (“government physician” contract) contribute more significantly to the reduction of technical inefficiency than others recruited on autonomous budget (“hospital physician” contract). This is explained by the removal of the evaluation of agents funded from the autonomous budget and the lack of department heads in many health facilities. Given the high proportion of staff financed on the autonomous budget (about 61.73%), we propose the resumption of the assessment of staff recruited on this budget and appointment of department heads in different hospitals. This would allow, first, establishing remuneration mechanisms based on performance, and second, sanctions. We also propose that the ministry organizes spot checks. Governance and leadership in public hospitals are critical to the achievement of high efficiency (Kirigia and Kirigia, 2011).

Another important finding was that the budget deficit is a source of increased inefficiency in public hospitals. This relationship may be partly because public hospitals depend on public subsidies. According to Kornai (2009), in a situation of budget constraint, by a mechanism of moral hazard, the dependence of hospitals to public subsidies has a negative impact on their efficiency. This observation may support the hypothesis that if subsidies are allocated according to performance, they can positively affect efficiency, using an incentive mechanism (Petitfour et al, 2015).

As noted previously, the Togolese public health system is characterized by a virtual absence of competition between public hospitals. The results in Table 8 show that the coefficient of the HHI is negative and significant. This suggests that competition between public hospitals in terms of offered outputs would significantly reduce the technical inefficiency of these hospitals. These results confirm the association between competition and public hospitals efficiency (Chua et al, 2011). According to our results, we can infer that non-competitive public provision of health services is likely to be inefficient.

Finally, the importance of demand side factors such as the density of covered population exhibits the fact that working on the governance and managerial aspects is not sufficient enough to improve public hospital efficiency (Petitfour et al, 2015). Outpatient health care must become more affordable (Petitfour et al, 2015) and health insurance offered by the National Institute of Health Insurance must enlarge its benefit package to vulnerable populations such as women, elderly, infant, and rural populations.

Limitations of the study

Several reasons explain why our results may seem disappointing at first. First, the number of hospitals studied was relatively low (139 out of 493). The level of accuracy or the sampling error was about 7.5%, a figure higher than the 5% level required. The dispersion of the estimated values around the mean was a little high. A more representative sample would lead to more robust results. In addition, methodologically, first, when the efficiency scores (dependent variable) are relatively correlated, it is efficient to employ a double Bootstrap approach. But for the robustness issue, it is recommended to use both Bootstrap and Jackknife methods. The estimated variance would be compared by using the Jackknife and the Bootstrap methods respectively. This was not applied in this study. Second, identifying efficient hospitals considers the quantitative inputs and outputs such as medical staff, paramedical staff, technical staff, number of beds and hospitalization number, which may not accurately describe and explain exactly the hospital inputs and outputs. Variables such as quality of equipment, staff absence, care quality, patient satisfaction would allow for stronger results.

One source of weakness which could have affected our results, was the case-mix indexed measurement. The outputs quality adjustment index used was not the best one. Owing to the unavailability of data for all hospitals studied, we were unable to use recommended factors such as percentage of board-certified physicians, doctor or nets per bed (Farsi and Filippini, 2005). Furthermore, the analysis reported in this paper is based on the data of hospital inputs and outputs from 2008 to 2010. Much has happened since 2010, notably in terms of the country's socio-economic and health development. Thus, future studies should consider these socio-economic and health developments in their investigation.

7. Conclusion

The Togolese public health system experiences enormous difficulties. For example, from 2008 to 2012, a significant increase in deaths of hospitalized patients occurred with an average annual increase of over 10%. In this paper, we analysed technical efficiency scores of 139 Togolese public hospitals and then identified the determinants of this efficiency. The study found heterogeneity in technical efficiency scores. This is explained by the fact that these health facilities are not homogeneous and do not have the same productive capacity. Factors explaining the technical efficiency are mainly per capita income, hospital size, competition, hospital balance, and medical density.

The paper suggests that accessibility and cost of treatment are more important for patients, especially in rural areas. Improvement in the population's purchasing power would lead to an increase in attendance at health facilities and in their efficiency. The study found that governance and leadership in public hospitals are critical to the achievement of high efficiency. However, our study had some limitations. Despite these limitations, this study had several strengths which may be generalized to some sub-Saharan African countries and others developing countries which have similar healthcare systems and socio-economic conditions.

According to our results, we can infer that non-competitive public provision of health services is likely to be inefficient. The results of this study indicate that universal health coverage could be a solution to address accessibility problems which may affect hospital efficiency. Greater efforts are needed to ensure healthcare quality monitoring system in public health facilities. Another important practical implication is that Togo must vigorously promote the reform of the public hospital management system which regards corporate quality governance as the core. We hypothesize that if subsidies are allocated according to performance, they can positively affect efficiency, using an incentive mechanism. Policy makers should consider tying grant revenues to performance indicators.

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