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Full Length Research Paper

Productivity of public hospitals in Togo: Hicks-Moorsteen's productivity index

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From 60% in 1990, attendance at public hospitals in Togo has declined significantly and is estimated at 30.08% in 2010. Less than half of child deliveries took place in these hospitals. From 2008 to 2012, it was noted that there was an average increase of patient deaths by 10%. This study aims at analyzing the sources of productivity changes in Togo public hospitals. The Hicks-Moorsteen's productivity index was used to analyze the productivity changes of 139 public hospitals over a period of four years (2008-2011). On average, productivity has declined significantly over the study period. This decrease is explained by the level of efficiency of large hospitals. The low level of efficiency of large hospitals is mainly due to a deficiency in the maintenance of medical equipment, aging biomedical equipment, lack of physicians, and inadequate infrastructure. Improving technical efficiency observed was found to be insufficient to increase productivity. The results suggest that the increase of technical efficiency has not yet reached the threshold required to trigger growth in productivity. Increasing technical efficiency would be the first goal to be set for improving public hospitals productivity. It should, also, encourage new investment that would improve production technology.

Key words: Hospital, productivity, technical efficiency, technical progress, Hicks-Moorsteen.

INTRODUCTION

In order to achieve the Millennium Development Goals (MDGs), African countries have pledged to improve the efficiency of their health care system, at the third ordinary session of the Conference of Ministers of Health of the African Union in 2007. National systems should implement mechanisms to improve the performance of health staff and care it offers. The report also indicates to incorporate the new opportunities offered by technological progress.

With an incidence of poverty estimated at 58.7% in 2011 and a rural population of approximately 73% below the poverty line (Coulombe et al., 2006), it can be noticed, through many speeches and policies that Togo is firmly committed to improving the health of its population drawing on WHO guidelines. However, curative cares are provided in deplorable conditions. An assessment of the state of health facilities that was conducted in Togo in 1995 showed that about 81% of them required simple renovation, rehabilitation or construction work (Ministry of Health, 2011). But so far, the situation has not improved significantly. In most health facilities and services, equipment and materials are insufficient at all different levels of the system (Ministry of Health, 2009). Many of these health facilities are dilapidated. The maintenance and upkeep of the buildings are inadequate and sometimes nonexistent. The existing medico-technical equipment is both inadequate and outdated and the minimum package of equipment is not met and does not meet the minimum required standards (Ministry of Health and OMS, 2004).

The Togolese public health system is further characterized by a shortage of medical and paramedical personnel in quantity and quality (Ministry of Health, 2009). In this study, an unequal distribution of medical and paramedical staff was noted. The richest region in Togo contains approximately 83% of the medical and paramedical staff. Six other sanitary regions abounds only 27% of the medical and paramedical staff.

In addition, the review of budgets allocated to health reflects a budget shortfall. The percentage of the budget allocated to health moved from 8.3% in 1991 to 4% in 2010 (Ministry of Health, 2011). These allocations are far from the commitments made by the Heads of States in Abuja Summit in 2000 which recommended an allocation of 15% of the general State budget to health.

These problems facing the health system affect the

demand for care. The health statistics show an under-utilization of the main services offered by hospitals. Compared to the 1990s, the current situation is alarming. From 60% in 1990, attendance at public hospitals in Togo has declined significantly and is estimated at 30.08% in 2010 (Ministry of Health, 2011). According to the Ministry of Health (2009), the cover rate in post native consultation remains low on the whole country and varied between 9.5% and 39.4%. At national level, barely half of all child deliveries (47.1%) take place in health facilities (Ministry of Health and OMS, 2004). Hospital activity in Togo reveals the finding of a health care system whose results are far below expectations.

Despite all these difficulties, many health policies continue to be developed, with the aim of improving the productivity of Togolese public hospitals without having previously identified the sources of increased productivity. Studies abound on hospital productivity. These studies can be grouped into six categories:

A first category where the positive evolution of technological change is the main increase productivity engine, though a slight improvement in technical efficiency can be noticed (Färe et al., 1997; Maniadakis et al., 1999; Sommersguter-Reichmann, 2000). A second category showing that the average increase of productivity is mainly due to an annual improvement of technical efficiency and a slight improvement of technological change (Giuffrida, 1999; Pham, 2011). A third category shows that improving hospital productivity is due to the improvement of pure technical efficiency and not to technical progress (Audibert et al., 2003; Burgess and Wilson, 1995; Kirigia et al., 2011). A fourth category for which none of the two components is statistically significant in explaining variations in productivity (Barros et al., 2008; Coelli et al., 2005). A fifth category for which a situation of technological regression coexists with the degradation of technical efficiency (Spinks and Hollingsworth, 2005). Finally, the last category for which productivity changes are explained mainly by technical progress (Barros et al., 2008).

Despite the multitude of studies, to our knowledge, there is none in Togo. This study aims, firstly, at bridging this gap. In addition, the Malmquist productivity index is most often used to analyze changes in productivity. However, it has been shown that this index is not always an index of Total Factor Productivity (TFP). As against, it has been shown that the productivity index of Hicks-Moorsteen correctly measures the change in productivity. In Sub-Saharan Africa, studies using the Hicks-Moorsteen productivity index in the field of health are few. This index has been used to assess the productivity of public hospitals in Togo. The objective of this study is to identify strategies to increase the productivity of public hospitals in Togo. Specifically, this is to:

- Check if the evolution of productivity is related to the change of efficiency or is attributable to technological change.
- Identify the most productive types of hospitals in the public hospital system.

METHODOLOGY AND DATA

Hospitals in the sample and their environment

With reference to the Ministry of Health (2009), public health facilities in Togo are organized into four levels with a more or less complete technical plateau. The first level represented by the Maternal and Infantile Protection Centers (MIPC) and Peripheral Health Units (PHU) includes 15 MIPC and 395 PHU. The second level is represented by 25 District Hospitals (DH) to which can be added two Specialized Hospitals (SH). Regional hospitals (RH), 6 in number, are the third level. University Teaching hospitals (UTH), 3 in number, are the last reference level of the national system.
To all these centers are added:

- At the central level, the National Center of Blood Transfusion (NCBT), the National Institute of Hygiene (NIH) which is the national reference laboratory.
- At the regional level, the regional centers for blood transfusion in the central and Kara regions.
- At the peripherals level, 64 Medical Social Centers (MSC) and Polyclinics (Poly).

The Togolese public health system consists of large hospitals (UTH and RH) and small size ones (PHU, MSC) generally located in low-income backgrounds. The poorest region, that is, the Savannah region is the most disadvantaged in public health facilities.

For an estimated population of 6,191,155 residents in 2010, coverage ratios provide one doctor for 16,035 inhabitants, one State nurse for 7,609 inhabitants and 1 midwife for 15,195 inhabitants (Ministry of Health, 2009). In addition to the deterioration ratios, there is a great disparity from one region to another, from one hospital to another, and between urban and rural areas. There is a high concentration in Lome, the capital city which had in 2009, 68.3% of all physicians.

This study focuses on a sample of 139 public health facilities including 3 UTH, 6 RH, 19 DH, 12 SMC, and 99 PHU. This sample consists of public health facilities in all health regions.

Measuring the change in productivity

Measuring concretely the productivity change poses many problems. Traditional price indices are the Fisher index, Tornquist index or even Bennet-Bowley index. The productivity index most commonly used is the Malmquist index (Malmquist, 1953). However, it has been shown that this index is not always an index of Total Factor Productivity (TFP). While the properties are verified under the assumption of constant returns to scale, problems or major defects appear in the presence of variable returns to scale, which largely represents the true technology

(Grifell-Tatjé and Lovell, 1999). There is also a possibility that the results lead to problems of infeasibility. One can refer to the works of Bjurek et al. (1998), Glass and McKillop (2000) and Zhou et al. (2008). To resolve this problem, Bjurek (1996) proposed the Hicks-Moorsteen productivity index.

Hicks-Moorsteen productivity index

This study was inspired by the decomposition of Total Factor Productivity of O'Donnell (2010, 2012).

Consider an output vector $y = (y_1,...,y_n)\ \varepsilon\ R_+^n$ and $x = (x_1,...,x_n)\ \varepsilon\ R_+^m$ a vector of input. The corresponding production technology per unit of production or decision $P: R_+^m \Rightarrow R_+^n$ is defined as follows:

$$T = \left\{(x,y)\ \varepsilon\ R_+^{m+n} \middle| (x,y)\ is\ \ feasible\ \right\}$$

Efficiency is measured using production frontiers and distance functions. Distances functions refer to the measurement of the efficiency of Farrell (1957). The efficiency $E_t(x_t, y_t)$ represents the inverse measure of the distance function of Shephard. Considering the input orientation, $E_t^i(x_t, y_t)$ indicates the minimum contraction of input vector by a scalar λ while using the same technology:

$$E_t^i(x_t, y_t) = \inf_{\lambda} \left\{\lambda : (\lambda x_t, y_t)\ \varepsilon\ T, \lambda \geq 0\ \right\}$$

$E_t^o(x_t, y_t)$ represents the measure of technical efficiency with output orientation and determines the maximum expansion of the vector by a scalar output θ with the same technology:

$$E_t^o(x_t, y_t) = \sup_{\theta} \left\{\theta : (x_t, \theta y_t)\ \varepsilon\ T, \theta \geq 1\right\}$$

Inspired by the quantity index of Malmquist (1953); Caves, Christensen, and Diewert (1982a) introduced two theoretical productivity indices of Malmquist: productivity indices in input and output orientation. These authors compared the input-output vectors for a reference technology using the radial scale inputs and outputs. Malmquist's quantity indices in output and input are respectively defined as follows:

$$MO_t(x_t, y_t, y_{t+1}) = \frac{E_t^o(x_t, y_t)}{E_t^o(x_t, y_{t+1})}$$

And

$$MI_t(x_t, x_{t+1}, y_t) = \frac{E_t^i(x_t, y_t)}{E_t^i(x_{t+1}, y_t)}$$

Diewert (1992) was the first to suggest an alternative approach to define the productivity index using distance functions based on the ratios of quantity indices in input and output of Malmquist. That approach qualified to be of Hicks-Moorsteen type was taken by Bjurek (1996) and Grifell-Tatjé and Lovell (1999). Bjurek (1996) defines the productivity index of Hicks-Moorsteen at time *t* as the ratio of a Malmquist output-oriented index over a Malmquist input oriented index at time *t*:

$$HM_t(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{MO_t(x_t, y_t, y_{t+1})}{MI_t(x_t, x_{t+1}, y_t)}$$

An index of Hicks-Moorsteen larger (smaller) than 1, indicates a gain (loss) on productivity. Over the period *t* +1, the productivity index of Hicks-Moorsteen is defined as follows:

$$HM_{t+1}(x_t, y_t, x_{t+1}, y_{t+1}) = \frac{MO_{t+1}(x_{t+1}, y_{t+1}, y_t)}{MI_{t+1}(x_t, x_{t+1}, y_{t+1})}$$

Along with,

$$MO_{t+1}(x_{t+1}, y_{t+1}, y_t) = \frac{E_{t+1}^o(x_{t+1}, y_t)}{E_{t+1}^o(x_{t+1}, y_{t+1})}$$

$$MI_{t+1}(x_t, x_{t+1}, y_{t+1}) = \frac{E_{t+1}^i(x_t, y_{t+1})}{E_{t+1}^i(x_{t+1}, y_{t+1})}$$

Similarly, a Hicks-Moorsteen index, larger (smaller) than 1 indicates a gain (loss) on productivity.

Since there are two possible Hicks-Moorsteen measures, based on period t and period t+1 technology, the Hicks-Moorsteen productivity index is defined as the geometric average of the two:

$$HM(x_t, y_t, x_{t+1}, y_{t+1}) = \left[HM_t(x_t, y_t, x_{t+1}, y_{t+1}).HM_{t+1}(x_t, y_t, x_{t+1}, y_{t+1})\right]^{1/2}$$

The interpretation is the same as that of the foregoing.

O'Donnell (2010) developed a DEA (Data Envelop Analysis) methodology to calculate and decompose Hicks-Moorsteen TFP index. He used the previous approach to conceptualize the different variants of variation measurements of TPF such as technological change measurements and various efficiency measurements namely: pure technical efficiency, mix efficiency, scale efficiency, the efficiency of the residual scale and residual mixed efficiency. The study of O'Donnell (2010, 2012) gives detail explanation for decomposition.

A firm knows an improvement (decline) when the technological index of technological change is greater than 1 (less than 1). As such, interpretation is identical to the change in technical efficiency.

Table 1. The different models used.

Variable	Input	Output
Model 1	Medical staff, paramedical staff, technical staff, administrative staff, number of beds	Admissions, ALOS, number of acts of surgery
Model 2	Medical staff, paramedical staff, technical staff, administrative staff, number of beds	Admissions, child deliveries, ANC

Source: Author.

Data

Data were extracted from the annual reports of health activities of each hospital. These data were supplemented by visits and interviews with hospital officials. The data cover the years 2008, 2009, 2010 and 2011.

Choice of inputs and outputs

Labor input

It can be classified into several categories. Some authors consider only two categories: “doctors and other staff” (Eakin, 1991) or “nursing and non-nursing” (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) or the “administrative staff, non-medical staff, technicians and support staff” (Vita, 1990). In this study, the labor factor is approximated by: medical staff, paramedical staff, technical staff, and administrative staff.

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, it will be estimated from the number of beds available at the health facilities (Audibert et al., 2008; Dervaux et al., 1997; Dukhan, 2010; Grosskopf and Valdmanis, 1987; Hollingsworth, 2003).

Output

As indicators of output, this study retained: ‘Admissions’ representing all individuals requesting a consultation at the hospital during the year (Afonso and Fernandes, 2008). The Average Length of Stay (ALOS) (Dervaux and Leleu, 1997; Linna, 1998), and the number of surgical act (Dervaux and Leleu, 1997). To these we can add: the total number of deliveries and the number of women who received Antenatal Care (ANC).

About 20% of the deaths of children aged below five happen during the first week after birth and can be attributed to child malnutrition and no or too little prenatal care (UNICEF, 2009). That is why prenatal consultations and medically-assisted births are key indicators of infant survival, infanto-juvenile survival and maternal mortality. These latter two indicators refer to the United Nations’ MDGs 4 and 5.

Two combinations of inputs and outputs were used (Table 1). orientation. In the Togolese context characterized by an inadequate budget and a shortage of staff and equipment, it would be inappropriate to seek to minimize the inputs instead of seeking to improve the output obtained. On the choice of returns to scale, we opted for variable returns to scale for several reasons:

(i) it is a general approach that is usually more suitable when it comes to taking into account the multi-output nature;

(ii) this approach enables one to control in part the bias related to the history of the hospital being studied (past investment, staff training, etc.); and

(iii) it enables a distinction between pure technical efficiency and scale efficiency.

RESULTS AND DISCUSSION

Descriptive statistics of variable

The Togolese public hospitals have in 2010 in their disposal an average of 6 medical staff for 100,000 habitants (hts), 69 para medicals for 100,000 hts and 13 technical persons for 100,000 hts. Yet, it is important to note the high dispersion of medical staff repartition by hospitals categories. The small size hospitals (PHU and SMC) have an average of less than one doctor for 100,000 hts, whereas large sizes (UTH, RH, and DH) have respectively an average and approximately 11, 7, and 37 doctors for 100,000 hts. This situation is well reported in the health training annuals reports where we can remark that the majority of small size hospital is devoid of doctors. A high density in terms of paramedical is seen in the PHU (Table 2). PHU and SMC; UTH, RH, and DH dispose respectively an average of 64, 36, 60, and 104 paramedical staff for 100,000 hts. The

Table 2. Statistics relative to the medical density.

Variable	Medical staff		Paramedical staff		Technical staff	
	Mean	Standard-deviation	Mean	Standard-deviation	Mean	Standard-deviation
UTH	10.578	5.404	35.894	22.222	32.869	11.398
RH	6.568	8.223	60.729	82.376	29.469	36.554
DH	36.737	42.301	103.944	69.429	30.630	29.581
PHU+SMC	0.648	4.853	64.642	141.741	8.915	34.88
Sample	6.051	20.480	69.223	131.205	13.287	35.037

Source: Author.

Table 3. Productivity change.

Model	Period	Variation of productivity	Technological change	Efficiency change
Model 1	2	1.87	1.83	0.89
	3	0.79	0.56	1.70
	4	0.678	0.37	2.27
Model 2	2	1.40	1.899	0.76
	3	0.999	0.593	1.68
	4	0.9145	0.524	1.74

Source: Author.

dispersions of outputs are relatively large with the exception of the Average Length of Stay. An analysis of the health pyramid allowed to better appreciate the wide dispersion of inputs and outputs especially at the outputs.

Empirical results

The DPIN 3.0 software developed by O'Donnell (2010) for analyzing productivity change was used to estimate and analyse the Hicks-Moorsteen productivity index. The year 2008 was considered as the reference technology.

On average, productivity in the public hospital sector has declined significantly over the four years of study, regardless of the model chosen (Table 3). It is observed, on average, a decrease in TFP by 32.2% and 8.55% over the period of 2010-2011 if we consider respectively the Models 1 and 2.

The analysis of the two components of productivity shows that technological change has been the main source of productivity growth in public hospitals. Whatever the model chosen, TFP growth periods are accompanied by a significant improvement of the technological level. Conversely, there is deterioration in terms of the variation level of technical efficiency. On average, technical efficiency has declined by about 11% and 24% respectively, considering the two models and the period of TFP growth (2008-2009).

Moreover, over the periods of 2009-2010 and 2010-2011, it was characterized by a decline in TFP; the results indicate a significant improvement in the level of technical efficiency and a significant reduction of technological progress. Considering Model 1 for example, and the period 2009-2010, the increase in technical efficiency on average by 70% and the simultaneous deterioration of the technological level of 44% resulted in an average decrease of the TFP by 21%.

The above shows in the first instance that technological change is the main source of TFP growth. Thus, the decline in the productivity of public hospitals is largely due to technological regression. As an example, the Bouladè PHU, Gandè PHU, and Gninguélia PHU have no transportation equipment for their activities. Most of the PHU have no analysis for laboratory.

These results are consistent with the work of Kirigia et al. (2011) which showed that in Benin, the decrease in hospital productivity was explained largely by technological decline over the period of 2003-2007. These results are consistent with the work of Färe et al. (1997), and Sommersguter-Reichmann (2000). Indeed, Sommersguter-Reichmann (2000) on a sample of 22 Australian hospitals showed that improving hospital productivity is mainly due to the improvement of technical progress. By cons, the results of this study contradict those of Pham (2011) who showed on a sample of Vietnamese hospitals that the average increase in productivity is mainly due to an annual improvement of technical efficiency and to a low improvement of technological change per year.

In a second step, the strong improvement of technical efficiency was found to be insufficient to increase TFP. It

Table 4. Breakdown of TFP by categories of hospitals.

Hospital	Hicks 2009/2010 Model 2								
	UTH+RH			DH			PHU+SMC		
	ΔTFP	$\Delta Tech$	ΔEff	ΔTFP	$\Delta Tech$	ΔEff	ΔTFP	$\Delta Tech$	ΔEff
NHI1	7	9	0	12	19	4	52	106	11
NHE1	2	0	0	2	0	0	0	0	0
NHS1	0	0	9	5	0	15	59	5	100
Average index	0.87	0.48	2.03	0.69	0.49	1.51	1.07	0.64	1.68
Variation (%)	-13.3	-51.8	103	-31.2	-51	50.8	6.7	-36.2	68.4

Source: Author.
Note: Number of hospitals with index inferior to 1 (NHI1), Number of hospitals with index superior to 1 (NHS1), Number of hospitals with index equal to 1 (NHE1).

is possible that the increase of technical efficiency has not yet reached the threshold required to trigger growth in productivity. Not only is this due to a misallocation of resources, but also and especially by production largely below the expected outputs. Huge efforts are therefore to be made by the Togolese health system to a significant increase in productivity.

The breakdown by category of hospitals confirms the previous results. Referring to Table 4, the breakdown of TFP by categories of hospital, also, reveals that the periods of negative change in technical progress and increase in technical efficiency lead to a decline in TFP. In addition, the breakdown of hospital categories revealed two major findings.

Unlike the previous results, it is observed, first, at the level of PHU and SMC positive change of TFP despite a negative change of technical progress and improvement of technical efficiency. These results thus reflect the fact that the decline in TFP sector can be explained mainly by the level of technical efficiency of large size hospitals (UTH, RH). Several reasons explain this low level of efficiency of large hospitals. From 2008 to 2010, it was noted a decrease of the patients admission by 19.57% at UTH Sylvanus Olympio. This was due, largely, to the rehabilitation work, the poor condition of beds, and the lack of physicians. It is also noted in these referral hospitals the lack of equipment such as the emergency kits, resuscitation equipment, and surveillance equipment. At RH kara, it was noticed a deficiency in the maintenance of medical equipment, aging biomedical equipment, and inadequate infrastructure.

The University Teaching Hospital (UTH) and Regional Hospitals (RH) are respectively the first and second referral facilities. It should be noted that Togolese health facilities are not homogeneous and do not have the same productive capacity. These referral hospitals, generally, face late admission of patients, late transfer of patients who are already in a hopeless state, and the lack of qualified personnel. Thus, several reasons could explain the level of inefficiency of the large hospitals.

Secondly, the search for a simultaneous growth of technical progress and technical efficiency would also sustain growth in TFP. From this point of view, the implementation of this objective would be linked, on the one hand, to the improvement in the efficiency of hospital managers by continuous optimization of the performance of their structure, and on the other hand, by the new investments that would increase production capacity and technology.

Conclusion

In this study, in which the productivity changes of 139 public hospitals was examined in Togo, two main objectives were defined: Check if the productivity change is related to the change of efficiency or is attributable to technological change and identify the most productive types of hospitals in the public hospital system.

In general, the results suggest that raising the level of productivity of the sector, the main difficulty lies in improving the level of technical efficiency, that is, improvements in terms of work organization, better knowledge of production processes, and the efficiency of resource allocation.

The increase in the technical efficiency of hospitals is the first goal setting to improve total factor productivity. It is therefore crucial today to develop sustainable policies to improve the level of technical efficiency of hospitals. The main question one might ask is: what are the factors that improve the technical efficiency of public hospitals in Togo? Is technical inefficiency due to internal or external factors for hospitals?

Finally, it is good to point out some limitations of this study. First, this study was limited to Hicks-Moorsteen productivity indices, but the same phenomena would most probably be observed by the Luenberger productivity indicator or Luenberger-Hicks-Moorsteen index developed by Briec and Kerstens (2004). Secondly, identifying efficient hospitals taking into account the quantitative inputs and outputs such as medical staff, paramedical staff, ALOS etc., may not accurately describe and explain exactly the hospitals' inputs and

outputs. Variables such as quality of equipment, staff absence, and care quality would enable this study to have more robust results.

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REFERENCES

Afonso A, Fernandes S (2008). Assessing and explaining the relative efficiency of local government. J. Soc. Econ., 37(5): 1946-1979.

Audibert M, Dukhan Y, Mathonnat J, Chen N, Ma A, Yin A (2008). Activité et performance des hôpitaux municipaux en Chine rurale. Une analyse sur données d'enquêtes dans la province de Shandong. Rev. Econ. Dev., 22(1): 63-100.

Audibert M, Mathonnat J, Henry MC (2003). Social and health determinants of the efficiency of cotton farmers in Northern Cote d'Ivoire. Soc. Sci. Med., 56(8): 1705-1717.

Barros CP, De Menezes, Peypoch N, Solonandrasana B, Vieira JC (2008). An analysis of hospital efficiency and productivity growth using the Luenberger indicator. Health. Care. Manag. Sci., 11(4): 373-381.

Bjurek H (1996). The Malmquist total factor productivity index. Scand. J. Econ., 98(2): 303-313.

Bjurek H, Førsund FR, Hjalmarsson L (1998). Malmquist productivity indexes: an empirical comparison Index Numbers: Essays in Honour of Sten Malmquist. Boston. Kluwer., 217-239.

Briec W, Kerstens K (2004). A Luenberger-Hicks-Moorsteen Productivity Indicator: Its relation to the Hicks-Moorsteen Productivity Index and the Luenberger Productivity Indicator. Econ. Theory., 23(4): 925-939.

Burgess Jr, Wilson PW (1995). Decomposing hospital productivity changes: a nonparametric Malmquist approach. J. Prod. Anal., 6(4): 343-363.

Coelli TJ, Rao, O'Donnell CJ, Battese GE (2005). An introduction to efficiency and productivity analysis. 2nd ed., Berlin, Springer.

Coulombe H, Akoly, Amouzouvi K (2006). Profile of Poverty Togo. PNUD. Togo.

Dervaux B, Leleu H (1997). Comparison of different measures of technical efficiency: An application to French hospitals. Econ. Prev., 129(130) :101-119.

Dervaux B, Leleu H, Escano G, Vincke B (1997). Efficacité productive des services hospitaliers et qualité des soins. Paper presented at the Acte des XIXèmes Journées des Economistes de la Santé Français.

Diewert WE (1992). Fisher ideal output, input, and productivity indexes revisited. J. Prod. Anal., 3(3) : 211-248.

Dukhan Y (2010). Améliorer l'efficience des systèmes de santé et la protection financière contre le risque maladie dans les pays en développement. Université d'Auvergne - Clermont-Ferrand I.

Eakin BK (1991). Allocative inefficiency in the production of hospital services. South. Econ. J., 58(1): 240-248.

Färe R, Grosskopf S, Norris M (1997). Productivity Growth, Technical Progress, and Efficiency Change in Industrialized Countries: Reply. Am. Econ. Rev., 87(5): 1040-1044.

Farrell MJ (1957). The measurement of productive efficiency. J. Roy. Stat. Soc., Series A (General): 253-290.

Folland ST, Hofler RA (2001). How reliable are hospital efficiency estimates? Exploiting the dual to homothetic production. Health. Econ., 10(8): 683-698.

Giuffrida A (1999). Productivity and efficiency changes in primary care: a Malmquist index approach. Health. Care. Manag. Sci., 2(1): 11-26.

Glass JC, McKillop DG (2000). A post deregulation analysis of the sources of productivity growth in UK building societies. Man. Scho., 68(3): 360-385.

Grifell-Tatjé E, Lovell CK (1999). A generalized Malmquist productivity index. J. Span. Soc. Stat. Oper. Res., 7(1), 81-101.

Grosskopf S, Valdmanis V (1987). Measuring hospital performance: A non-parametric approach. J. Health. Econ., 6(2): 89-107.

Hollingsworth B (2003). Non-parametric and parametric applications measuring efficiency in health care. Health. Care. Manag. Sci., 6(4): 203-218.

Kirigia JM, Sambo LG, Mensah O, Mwikisa C, Asbu E, Makoudode P, Hounnankan A (2011). Productivity changes in Benin Zone hospitals: a non-parametric Malmquist approach. Afri. J. Health. Econ.

Linna M (1998). Measuring hospital cost efficiency with panel data models. Health. Econ., 7(5): 415-427.

Malmquist S (1953). Index numbers and indifference surfaces. Trab. Est., 4(2): 209-242.

Maniadakis N, Hollingsworth B, Thanassoulis E (1999). The impact of the internal market on hospital efficiency, productivity and service quality. Health. Care. Manag. Sci., 2(2): 75-85.

Ministry of Health (2009). National Health Development Plan (2009-2013). Lome. Togo.

Ministry of Health (2011). Key Indicators of Health. Lome. Togo.

Ministry of Health, WHO (2004). Togo's Health System Profile. Lome. Togo.

O'Donnell CJ (2010). DPIN version 1.0: a program for

decomposing productivity index numbers: School of Economics, University of Queensland, Australia.
O'Donnell CJ (2012). An aggregate quantity framework for measuring and decomposing productivity change. J. Prod. Anal., 38(3): 255-272.
Ozcan YA, Luke RD (1993). A national study of the efficiency of hospitals in urban markets. Health. Serv. Res., 27(6): 719.
Pham TL (2011). Efficiency and productivity of hospitals in Vietnam. J. Health. Organ. Manag., 25(2): 195-213.
Scuffham PA, Devlin NJ, Jaforullah M (1996). The structure of costs and production in New Zealand public hospitals: an application of the transcendental logarithmic variable cost function. App. Econ., 28(1): 75-85.
Sommersguter-Reichmann M (2000). The impact of the Austrian hospital financing reform on hospital productivity: empirical evidence on efficiency and technology changes using a non-parametric input-based Malmquist approach. Health. Care. Manag. Sci., 3(4): 309-321.
Spinks J, Hollingsworth B (2005). Health production and the socioeconomic determinants of health in OECD countries: the use of efficiency models. Working Paper. Centre for Health Economics.
Steinmann L, Zweifel P (2003). On the (in) efficiency of Swiss hospitals. App. Econ., 35(3): 361-370.
UNICEF (2009). La situation des enfants dans le monde 2009.
Zhou P, Ang BW, Poh KL (2008). A survey of data envelopment analysis in energy and environmental studies. Eur. J. Oper. Res., 189(1) : 1-18.