MEASURING SCHOOL PERFORMANCES IN BURKINA FASO

W. Jacob Yougbaré, Jacques Teghem

Abstract— At the prospect to increase the performance of the basic educational system, the Burkina Faso Government established the program called PDDEB. To achieve the expected results, it is important that the performance of base units under control can be evaluated each year to adjust, if necessary, the strategy for resource allocation.

We used Data Envelopment Analysis (DEA) methods to measure the efficiencies and the indices of Malmquist of the 45 provinces of Burkina Faso

The Government of Burkina Faso continued to allocate resources according to the PDDEB. The returns will be even greater if these allocations reflect efficiencies in each direction. This study shows that the majority of the technically inefficient provinces need to increase the number of schools to improve their efficiency.

The Department in charge of the basic education has never used the results providing quantitative measures on the performance of directions. This work is a first using DEA to address this concern to assess performance for the case of Burkina Faso. The limited data do not give a very thorough analysis of the efficiency and impact of certain factors such as cultural, socio-economic, geographical and political factors on the efficiency.

Index Terms— *DEA, efficiency, schools, performance indicator, performance measurement, productivity*

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1 Introduction

Data Envelopment Analysis (DEA) was introduced by Charnes, Cooper and Rhodes (1978) to evaluate and compare the performances of "Decision making units" (DMUs). This method, now applied in many sectors, uses nonparametric mathematical programming. DEA allows measuring the efficiency of the activities of a sector without seeking to incorporate, using weight, the various inputs and outputs. The importance of the efficiency analysis in the sectors of education and teaching institutions is growing as the many applications show it. On the one hand, one seeks to determine the criteria (quantifiable or definable) to take into account to explain the performance and the productivity of an education system. On the other hand, one seeks to determine the necessary resources to improve these criteria. The growing attention paid to the social field in general and education in particular is perceptible through the increasing number of studies, psychological, sociological, philosophical, economic, etc. which try to explain the concept and the need for a good education. Moreover, the financial and technical partners of the programs for the development of education seek to evaluate in one way or another, the outputs of their investments in this sector. Most countries, and in particular developing countries, have adopted national policies to meet the requirements of sustainable development. This has led political decision makers to stress the social sectors, like education. These decision-makers also seek to measure the performances and to evaluate their programs of human development.
Burkina Faso has adopted a 10-year program "Decennial Program for the Development of Basic Education" (DPDBE) for the period 2001 -- 2010. This program aims at improving the performances of the basic education system starting from the indicators defined in the document containing the main trends of the national policy for the same period "Poverty Reduction Strategy Paper" (PRSP).
This paper starts with a review of the literature relating to some applications of the DEA method in the sectors of education and teaching institutions (section I); the methodology is presented in section II; DEA is applied to measure the performances of the provinces of Burkina Faso, using the data for the years 2004 and 2005 (section III); we analyzed the inefficiencies of the provinces for these two years, using the Charnes, Cooper and Rhodes (CCR) and Banker, Charnes and Cooper (BCC) models and finally we draw conclusions relating to our results and analysis.

2 Literature review

The literature abounds in works and publications on the education systems and teaching institutions, concerning all fields of education (the psychology of education, the philosophy of education, the sociology of education, the economics of education, etc.) In the majority of these works on education, the authors seek to understand, explain or justify the technology of education i.e. the transformation of the resources in to socio-economic, political, cultural, financial goods, etc. This approach of education as a process in which resources are transformed into educational products leads certain researchers to justify the choice of parameters as being educational goods or needs for a good education. Concerning the applications to education, several works using approach DEA have already been carried out.

Charnes, Cooper and Rhodes proposed in 1978 a DEA model to measure the educational system efficiency and to explain the sources of inefficiency. The authors used DEA to evaluate the activities in public programs relating to education. This method later turned out to be a very important non-parametric method for aiding the managers in social sectors, like education and health, to identify the efficient technology. Technology here refers to the process set up to transform the available resources into objectives or products.

Ray in 1991, used DEA to estimate the relative efficiencies of the public schools in the districts of Connecticut (USA). He regards as input variables the ratio of teachers to pupils, the ratio of administrative staff to pupils and administrative support to pupils. He considers as output variables the average grade rate in the 9th year of study in mathematics, reading and writing.

Banker, Janakiraman and Natarajan (2004) used DEA to analyze the technical efficiency and allocation efficiency in education. They regard as inputs the operational expenses (in the implementation of the program) and, as output, the enrolment.

Other authors, as Kirjavainen and Loikkanen (1998), added to the set of input variables, the teaching time per week, actual teachers' experience and the educational level of the parents. As outputs, they considered the number of pupils taking their end-of-cycle examination and the number of those passing it.

Many other papers examine applications relating to education and using DEA to consider the efficiency of the educational system or teaching institutions, like: Gstach, Somers and Warning (2003), Grosskopf and Moutray (2001) for the high schools in Chicago, Ruggiero (1996, 1999), Ruggiero et al. (2002),Conceição et al. (2001), Avkiran (2001), Abbott and Doucouliagosa (2003), Johnes and Johnes (1995), Thursby and Kemp (2002) etc.

To measure the efficiency of a given educational program, the authors generally consider that the decision-making for the adjustment of school programs must take into account the resources relative to:

- the pupils, such as the socio-economic, financial background, etc.
- the parents, such as the educational level, the living standard, social background, etc.
- the teachers, such as the training level, experience, motivation, etc.
- the education institutions, such as the material resources, personnel, etc.

Other factors (socio-economic, financial, geographical, cultural factors, etc.), often more difficult to quantify or qualify but which contribute to better education, are sometimes also considered. The outputs to be considered are even more complex and often neither quantifiable nor definable. Generally, one takes into account the performance indicators relating to the enrolment, gender parity, the success at the end of the cycle, etc.

Numerous papers deal with the choice of criteria in efficiency measurement. Bifulco and Bretschneider (2001) described the complexity of the analysis of educational productivity, Michaelowa (2001) shows that the availability of textbooks (for the pupils as for the teachers) is an important factor in academic success (application relating to the francophone countries of sub-saharan Africa).

3 METHODOLOGY

In this study we use DEA method to measure the performances of the 45 Provincial Directions of Basic Education in Burkina Faso for two years (2004 and 2005) . The CCR model is used to determine the technical efficiency of the provinces and to analyze the sources of technical inefficiency. The BCC model is used to determine the efficiency of scale, which makes it possible to take into account the variable returns to scale (constant, decreasing or increasing) of the provinces.

The advantage of using DEA for the analysis of the performances in the education system is that it makes it possible to build what is called a technology of production using only the data observed, without previously assigning weights to the various factors or decision-making units. We understand by technology in this work, the program and the set of methods and techniques used to transform the input factors into output factors. In the DEA approach, the technology is characterized by the efficient frontier of production. Thus all the units on the efficient frontier of production have the best possible productivity. The others on the contrary are inefficient. In this case, inefficiencies are given by the differences observed between the efficient frontier of production and the data observed. In the same way, the sources of inefficiency are given by these differences observed.

The variables considered in this study are assumed not to be rigid. The inputs can be reduced or increased to improve the outputs. In other words, the various input and output factors used are assumed as controllable on the provincial level.

3.1 The DEA approach

DEA compares the efficiency of each decision-making unit to the others in the system and to itself. It calculates the optimal ratio output-input by measuring the maximum of the ratio of the weighted sum of the output factors compared to the weighted sum of the input factors. The CCR and BCC input-oriented models are used in this study. They consist in determining, for a given set of observations, the minimal value of the inputs to produce the output factors (given the observed data). By mathematical programming, the method determines the associated optimal weights and the corresponding efficient frontier. This frontier is regarded as the frontier of better productivity or efficient productivity.

A system with n DMUs is considered and these various DMUs are indexed by j, j=1…n. Each unit j uses x_{ij} of the input variable i,i=1…m and produces y_{rj} of the output variable r,r=1...s, with m the number of input variables and s the number of output variables. The vector of the input variables corresponding to unit j will be noted X_j. and that of the output variables Y_j. We note by d, d∈ $\{1,\dots,n\}$, the unit which is under evaluation by the DEA method.

The CCR linear model with input orientation (Charnes et al., 1978), which incorporates slack variables, is the following linear problem:

$$\min \quad h_d = \tau_d - \epsilon\left(\sum_{i=1}^{m} s_i^{-d} + \sum_{r=1}^{s} s_r^{+d}\right)$$
$$s.t. \begin{bmatrix} \sum_{j=1}^{n} \lambda_j^d x_{ij} - \tau_d x_{id} + s_i^{-d} = 0, \forall i; \\ \sum_{j=1}^{n} \lambda_j^d y_{rj} - y_{rd} + s_r^{+d} = 0, \forall r; \\ s_i^{-d} \geq 0, \forall i; s_r^{+d} \geq 0, \forall r; \lambda_j^d \geq 0, \forall j \end{bmatrix} \quad (1)$$

This CCR model is used to measure technical efficiencies of DMUs.
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The BCC model (Banker et al., 1984) is used to measure efficiencies of scale. The BCC envelopment form is obtained by adding the constraint of convexity $\sum_{i=1}^{n} \lambda_i^d = 1$ to the CCR model (1).

Definition 2.1: *A DMU d is efficient (CCR or BCC), if and only if, the optimal value of τ_d equals unity ($\tilde{\tau}_d = 1$) and all the slack variables equal zero ($\tilde{s}_i^{-d} = 0, \forall i; \tilde{s}_r^{+d} = 0, \forall r$).*

To understand the concept of variable returns to scale that the model of Banker, Charnes and Cooper takes into account, let us consider the following:

Definition 2.2: *There are increasing (economies of scale), decreasing or constant returns to scale, respectively, when the increase in the values of the input factors produces proportionally larger, smaller or identical increase, in the level of the output factors.*

For example, when the decision maker increases by 1% the quantities of the inputs, the output factors increase by more than 1%, less than 1% or 1%, respectively

To characterize the variable returns to scale, we will use the approach suggested by Banker et al. (1996), Zhu and Shen (1995). To that aim the following linear problems are solved:

$$\xi^d = \min\{\tau: \sum_{i=1}^{n} \lambda_i X_i \leq \tau X_d; \sum_{i=1}^{n} \lambda_i Y_i \geq Y_d; \lambda_i \geq 0, j = 1,\dots,n\}$$
(2)

$$\beta^d = \min\{\tau: \sum_{j=1}^{n} \lambda_j X_j \leq \tau X_d; \sum_{j=1}^{n} \lambda_j Y_j \geq Y_d; \sum_{j=1}^{n} \lambda_j = 1; \lambda_j \geq 0, j = 1,\dots,n\}$$
(3)

$$\gamma^d = \min\{\tau: \sum_{j=1}^{n} \lambda_j X_j \leq \tau X_d; \sum_{j=1}^{n} \lambda_j Y_j \geq Y_d; \sum_{j=1}^{n} \lambda_j \leq 1; \lambda_j \geq 0, j = 1,\dots,n\}$$
(4)

Theorem 2.1: *(Banker et al., 1984; Zhu et al., 1995; Banker et al. 1996) There are at point (X_d, Y_d):*

i. increasing returns to scale or economies of scale, if and only if, $\xi^d < \beta^d$ and $\gamma^d = \xi^d$;

ii. constant returns to scale, if and only if, $\xi^d = \beta^d$;

iii. decreasing returns to scale, if and only if, $\xi^d < \beta^d$ and $\gamma^d = \beta^d$.

3.2 2.2. Measuring Malmquist productivity indices using DEA

The index of productivity of Malmquist, a concept introduced by Caves et al. (1982) was applied by Färe et al. (1996), Chen and Ali (2004) by using the DEA approach. For two periods t_0 and t_1 given, the index of Malmquist measures the change in productivity. Färe et al. (1996), as Chen and Ali (2004) distinguish the change in the technical efficiency which represents a change in the distance to the efficient frontier of production in period t_0 compared with period t_1. On the other hand, a change in the technology of production represents a shift of the efficient frontier of production.

We will note that at a given period t, DMU j produces quantity y_{rj}^t of the output factor r, r=1… s and uses quantity x_{ij}^t of the input factor i, i=1… m. X_j^t and Y_j^t respectively represent the input and output vectors of DMU j at period t . $w_j^t = (X_j^t, Y_j^t)$ indicates the factor of production of DMU j.

We use (˜) to indicate the optimality of the solution and

$P^t = \{(x,y): x \geq \sum_{j=1}^{n} \lambda_j X_j^t, y \leq \sum_{j=1}^{n} \lambda_j Y_j^t, \lambda_j \geq 0, \forall j\}$ the set of the possible productions in period t (CCR model).

To measure the technical efficiency of DMU d at period t_0, the following problem is solved:

$$\tilde{\tau}^{t_0}(w_d^{t_0}) = \min\{\tau: (\tau X_d^{t_0}, Y_d^{t_0}) \in P^{t_0}\}$$
(5)

The same formula is used to measure the technical efficiency $\tilde{\tau}^{t_1}(w_d^{t_1})$ at period t_1 by using the values of the DMU at period t_1.

The value $\tilde{\tau}^{t_0}(w_d^{t_1})$ compares the efficiency of the DMU d in period t_1 and in period t_0. It is calculated by:

$$\tilde{\tau}^{t_0}(w_d^{t_1}) = \min\{\tau: (\tau X_d^{t_1}, Y_d^{t_1}) \in P^{t_0}\}$$
(6)

In the same way, the value $\tilde{\tau}^{t_1}(w_d^{t_0})$ compares the efficiency of DMU d in period t_0 with period t_1.

$$\tilde{\tau}^{t_1}(w_d^{t_0}) = \min\{\tau : (\tau X_d^{t_0}, Y_d^{t_0}) \in P^{t_1}\} \quad (7)$$

Definition 2.3: *The index of productivity of Malmquist, M_d, which measures the change in productivity of a DMU d from the period t_0, to period t_1 is defined as:*

$$M_d = \left[\frac{\tilde{\tau}^{t_0}(w_d^{t_1})}{\tilde{\tau}^{t_0}(w_d^{t_0})} \cdot \frac{\tilde{\tau}^{t_1}(w_d^{t_1})}{\tilde{\tau}^{t_1}(w_d^{t_0})}\right]^{\frac{1}{2}}$$

This index provides explanations on the change in performance of the efficient units. Färe et al. (1996) as Chen and Ali (2004), provided the following results for an efficient unit d for the two periods t_0 and t_1:

- $M_d > 1$ indicates a positive change in the productivity of the DMU in period t_0 compared to period t_1 (performance profit);
- $M_d < 1$ indicates a negative change in the productivity of the DMU in period t_0 compared to period t_1 (performance loss).
- $M_d = 1$ indicates that there is no change in the productivity of the DMU in period t_0 compared to period t_1.

Färe et al. (1996), Chen and Ali (2004) generalized this measurement of the index of productivity of Malmquist to all the units (efficient and non-efficient) by decomposing the index M_d as:

$$M_d = TEC_d \cdot FS_d \quad \text{with} \quad TEC_d = \frac{\tilde{\tau}^{t_1}(w_d^{t_1})}{\tilde{\tau}^{t_0}(w_d^{t_0})}$$

$$\text{and} \quad M_d = \left[\frac{\tilde{\tau}^{t_0}(w_d^{t_1})}{\tilde{\tau}^{t_1}(w_d^{t_1})} \cdot \frac{\tilde{\tau}^{t_0}(w_d^{t_0})}{\tilde{\tau}^{t_1}(w_d^{t_0})}\right]^{\frac{1}{2}}$$

- TEC_d measures the change in technical efficiency of DMU d between periods t_0 and t_1;
- FS_d measures the change in technology of production of DMU d between periods t_0 and t_1.

This decomposition provides the following results for all efficient or inefficient DMUs:

- $TEC_d > 1$ indicates that in t_1 DMU d is coming closer to the efficient frontier compared to t_0. That represents a technical efficiency profit;
- $TEC_d < 1$ indicates that in t_1 DMU d is moving away from the efficient frontier compared to t_0. That represents a technical efficiency loss;
- $TEC_d = 1$ indicates there is no change in the distance between DMU d and the efficient frontier in t_1 compared to t_0. There is no change in technical efficiency;
- $FS_d > 1$ indicates a positive change in the technology of production (technology progress) of DMU d in t_1 compared to t_0;
- $FS_d < 1$ indicates a negative change in the technology of production (technology regress) of DMU d in t_1 compared to t_0;
- $FS_d = 1$ indicates there is no change in the technology of production of DMU d in t_1 compared to t_0.

Note: There are several possibilities for a given value of the index of Malmquist M_d, depending on the values of TEC_d and FS_d (Chen et al., 2004):

i. $TEC_d > 1$, $FS_d > 1 \Longrightarrow M_d > 1$: this situation implies that DMU d adopted a suitable strategy, which not only made it possible to have a technical efficiency profit but also to improve the technology of production;

ii. $TEC_d < 1$, $FS_d < 1 \Longrightarrow M_d < 1$: this situation implies that DMU d adopted a bad strategy and sees not only a technical efficiency loss but also a technology regression;

iii. $TEC_d > 1$, $FS_d < 1$: this situation implies that DMU d can have $M_d > 1$ or $M_d < 1$. When $M_d < 1$, the productivity loss is due to a negative change in technology; and, when $M_d > 1$, the productivity profit is primarily related to a profit in technical efficiency;

iv. $TEC_d < 1$, $FS_d > 1$: this situation implies that DMU d can have $M_d > 1$ or $M_d < 1$. When $M_d < 1$, the productivity loss is related to a loss in technical efficiency; and, when $M_d > 1$, the productivity profit is primarily related to a positive change in the technology of production.

4 Performances in basic education in Burkina Faso

4.1 Indicators of the educational performances

The concept of educational efficiency (of provinces) is relative since it depends on the factors considered in the models. To define these factors, the actors of education agree on the principle that the units of the education system need the resources (human, financial, physical, material, socio-economic, etc.) to generate educational products (schooling, enrolment, success in exams). The objectives of the political decision-makers and other financial and technical educational partners are measured by indicators of enrolment in schools, success in the end-of-cycle's examinations and taking into account of gender parity. The system considered in this study is basic education in Burkina Faso. The educational policy of Burkina Faso and its orientations are defined in the PRSP so as to meet the requirements of sustainable development. The government of Burkina Faso regards the social sectors such as health and education, and in particular basic education, as top priority sectors. Their orientations are laid down by "axis 2: to guarantee the access of the poor to the basic social services" (PRSP, version of 2004).

With regard to basic education, the Decennial Program for the Development of Basic Education Teaching makes it possible to improve the performances of the education system, while following the directives defined in the PRSP. The follow-up and the evaluation of these performances are measured by indicators defined in agreement with the financial partners (national and international) and all those taking part in education. Thus the first objective for education is "*to shake the education system out its lethargy and move from a rate of primary schooling of 40.3% in 1999 to 70% in 2010, a particular accent being put on the increase in that of the girls which should go up from 36% to 65% for the same period*" (PRSP). The report "*Monitoring Progress in the implementation of the Poverty Strategy Reduction Paper -- section basic education*" (PRSP, version of March 2003), clearly emphasizes the principal indicators of follow-up for the development of the sector of basic education. They are the rate of schooling, the rate of enrolment and the newly registered pupils in primary education. The specific objectives for the development of the basic education system, stress the importance which the state attaches to schooling (its growth), gender parity and also to the improvement of the "*quality, the relevance and efficiency of basic education by the training of teaching staff and managing staff (inspectors and education advisers)*" (PRSP).

4.2 School variables and data of the provinces

The data relating to the pupils, teachers, schools concerning the provincial directions used in this study were provided to us by the ministry in charge of Basic Education and Literacy of Burkina Faso through the direction of the studies and planning. Information relating to success in end of primary education examinations, the Certificate of primary education (CPE), comes from the direction of Examinations and Contests of the same ministry[1].

To measure the school performances, 4 types of input factors relating to the resources used in primary education teaching are considered:

- the human resources represented by the teachers, taking experience into account, as denoted by their position in the hierarchy. Teachers in primary education belong to either of the following classes: Assistant Teachers (AT), Certified Assistant Teachers (CAT), Certified Teachers (CT) and Principal Teachers (PT) and other volunteers and/or staff without prior teacher training. Are considered here certified: CAT, CT and PT. Promotion from one position to a higher one is based on seniority and/or training level;
- physical resources of the schools, i.e. the classrooms;
- resources relating to management and direction of the schools represented by the inspectors and principals. In our models Certified Teachers (CT) and Principal Teachers (PT) represent the directors. Normally the direction of the schools is entrusted to a PT and failing this, a CT. However a teacher of lower rank may be in charge of the direction. The inspectors are represented by the inspections, each of which has 2 representatives at most (inspector and/or education adviser). This number is nearly constant in all the inspections. The inspection is generally made up of an inspector who is the head of the district and an itinerant education adviser. While the former has the role of a supervisor of the activities of the District of Basic Education (DBE), the latter, the education adviser, has a very active role of control, follow-up and coordination of the teaching activities in the district.

In terms of objectives or outputs to maximize, 4 output factors are considered:

- rates of schooling in primary education ;
- rates of enrolment in primary education ;
- rates of CPE success;
- the index of gender parity.

The various variables for the years 2004 and 2005 are defined as follows:

- X_1 represents the classrooms-pupils ratio: (number of classrooms/number of the pupils)*1000. This variable is an indicator of the capacity of accommodation in primary education;
- X_2 represents the certified teachers-classrooms ratio: (number of certified teachers /number of classrooms)*10. This variable measures the capacity of training of the forms by certified teachers, which determines the quality of training. Indeed, certified teachers have been trained by National

[1] Some statistical data were provided to us already treated (rate of schooling, rate of enrolment, rate of CPE success), contrary to rough data from DEP/MEBA, which relate to the numbers of pupils, teachers, schools, classrooms. As a result, we are solely responsible for errors that might occur in the data used in this work

Schools of Teachers of Primary Education (NSTP). It is therefore an indicator of quality of primary education teaching;

- X_3 represents the CT or PT teachers-schools ratio: (number of CT or PT teachers /number of schools)*10. This variable enables to measure the quality of the management of the schools. Since the direction of the schools is entrusted to PT teacher trained to this end and, failing this, to CT teacher, this variable measures the performance from the management point of view of the schools in the provincial directions;
- X_4 represents the inspections-schools ratio: ({number of inspections}/ {number of schools})*100. This variable measures the capacity to control management and teaching in the schools. Indeed, the districts are responsible for supervising, controlling and coordinating the lessons, the teachers and the management of schools;
- Y_1 represents the rate of schooling: (total of pupils in primary education /total of the population aged 7 to 12)*100. This variable measures access to school and participation of the population of age to be in primary education. This indicator provides information on the total capacity of a direction to provide primary education;
- Y_2 represents the rate of enrolment in primary education: (total pupils in first year of primary education/total of the population aged 7)*100. This variable measures access and participation of the population old enough to begin primary school and provides information on the capacity required in the first year of primary education;
- Y_3 represents the index of gender parity: (rate of schooling of the girls/rate of schooling of the boys)*100. This variable measures the gender equity in education in a given province;
- Y_4 represents the rate of success on the Certificate of Primary Studies. It measures the quality of teaching in primary education in a given province.

An overview of the minimal values (Min), maximum (Max), average, standard deviation (St-D), quartiles 1 (Q1 25%) and 3 (Q3 75%) of the factors (input-output) considered show that the averages of the input factors clearly dropped in 2005 compared to 2004 except for the factor concerning the inspections which increased in the same period. This can be explained by the fact that:

- the demand for schooling increased relatively more than the offer, as translated by the classrooms;
- the policy led by the government which consists in increasing the physical resources (schools and classrooms) is more important than that concerning the recruitment and the training of teaching staff;
- the promotion of certified teachers to CT or PT was weak relative to the availability of the schools.

As for the increase in the average of the factor concerning inspections, it is related to the policy of decentralization implemented by the government. In the same period, the number of districts of basic education grew by 25.56% from 211 to 265. Averages in output factors increased except those relating to the CPE examinations. These increases reflect the performances of school output in spite of the fall in input factors.

5 Analysis of Inefficiencies in the Provinces

5.1 Technical efficiencies of provinces

The input-oriented CCR model is used for measuring the technical efficiencies of the 45 provinces.

- the average score of the technical efficiency was respectively 0.9221 (92.21%) and 0.9140 (91.40%) in 2004 and 2005 for the whole of the provinces;
- the number of provinces on the efficient frontier of production was 16 (35.56%) and 14 (31.11%) respectively in 2004 and 2005.

These results show that it would be necessary for the system to reduce the input factors by 7.79% and 8.60% respectively for the two years to improve the performance of the system. In the models used here, reducing input factors amounts to reducing the ratios classrooms--pupils, certified teachers--classrooms, CT, PT teachers--schools and the ratio inspections--schools.

The technical inefficiency of a system can be related to the inefficiency of resource allocation or to inefficiency resulting from failing to obtain the better objectives (quantitative and qualitative). The CCR model allows identifying the sources of technical inefficiency by means of the slack variables. These slack variables obtained show that the average deviations between the data observed and the efficient frontier clearly dropped in 2005 compared to 2004, except for gender parity, which increased.

The data show that variable X_1 does not emerge as a source of technical inefficiency for any of the provinces. Considering the definition of this variable, it means that all the provinces have almost the same policy of distribution of the classrooms compared to the demand for schooling (number of pupils). As for the other input factors, the model shows that on average, there is no significant difference between the resources (the inputs) observed in the inefficient provinces and the optimal values observable in the best technology of production on the efficient frontier of production.

Indeed, in 2004, these is for example only one average surplus of 2.89 in input factor 2, which represents an average variation of 2.89 certified teachers for 10 classrooms. The average deviation of input factor 3 is 0.12 for the same year, which means a variation of 0.12 CT or PT teacher for 10 schools and 0.19 inspection for 100 schools. These surpluses imply that it is necessary to (relatively) increase the number of classrooms and the number of schools in these inefficient provinces to improve the school outputs.

With regard to the output factors, the model shows that inefficiencies of the provinces are strongly related to inefficiencies of output (of school production). Indeed, the model shows that the technically inefficient provinces in 2004 for example must improve their educational outputs by increasing on average by 6.45% their schooling rate Y_1, by 5.11% their enrolment rate Y_2, by 0.027 their gender parity rate Y_3, and by 3.84% their CPE success rate Y_4, to adopt the best technology of production. The synthesis of the average deviations of the various factors gives for 2004 and 2005 respectively :

- surpluses of input factors: 2.89 and 2.36 X_2 (certified teachers for 10 classrooms); 0.12 and 0.06 X_3 (CT or PT teachers 10 schools); 0.19 and 0.20 X_4 (inspections for 100 schools);
- deficits of output factors (school products): 6.45% and 5.95% Y_1 (rate of schooling); 5.11% and 1.05% Y_2 (rate of enrolment); 2.74% and 6.78% Y_3 (gender parity index); 3.84% and 2.60% Y_4 (CPE success rate).

5.2 Efficiency of scale in provinces

The BCC model used to measure the efficiency of scale in the provinces provides the following results for 2004 and 2005 respectively :

- an average efficiency of scale score of 0.9483 (94.83%) and 0.9450 (94.50%). This means that it would be necessary to reduce input factors by 5.17% and 5.50% to improve the performances observed, by taking account of variable returns to scale;
- 20 and 17 scale efficient provinces i.e 44.44% and 37.78% of the set;
- 4 and 3 efficient provinces present decreasing returns to scale;
- 16 and 14 efficient provinces present increasing returns to scale.

For the provinces with decreasing returns to scale, a short-term policy must seek to reduce input factors to improve the school output i.e. to reduce ratios classrooms--pupils, certified teachers--classrooms, CT or PT teachers--schools, and the ratio inspections--schools in these provinces. For the provinces with increasing returns to scale, a short-term policy for the improvement of the school performances must seek to increase input factors in these provinces.

The results for efficiency of scale obtained show that variable X_3 is not a source of inefficiency of allocation for any of the localities. This means that the policy of distribution of this input factor is optimal. This factor corresponds to the ratio CT or PT teachers per school. Just as in the first model (CCR), it should be noted that there is no significant difference between the input quantities observed in the inefficient units and the optimal quantities on the efficient frontier of production. Indeed, for example in 2004 there are on average only surpluses of 0.09 classrooms for 1000 pupils, of 2.21 certified teachers for 10 classrooms, and of 0.14 inspections for 100 schools. One also notices that it is necessary to increase the number of classrooms, and the number of schools to improve the school output in these provinces.

Just like the CCR model, the BCC model shows that the inefficiencies of the provinces are strongly related to inefficiencies in school output. The inefficient provinces in 2004 for example can improve their educational output by increasing on average by 6.94% their schooling rate Y_1, by 6.13% their enrolment rate Y_2, by 6.60 their gender parity rate Y_3, and by 5.44% their CPE success rate Y_4, to be on the efficient frontier of production.

The optimal variations of the factors with BCC are on average, for 2004 and 2005 respectively:

- for the surpluses of the input factors: 0.09 and 0.00 X_1 (classrooms for 1000 pupils); 2.21 and 1.78 X_3 (certified teachers for 10 classrooms); 0.14 and 0.21 X_4 (inspection for 100 schools);
- for the deficits of output factors (school product):6.94% and 6.56% Y_1 (schooling rate); 6.13% and 4.83% Y_2 (enrolment rate); 6.60% and 6.84% Y_3 (gender parity index); 5.44% and 6.85% Y_4 (CPE success rate).

6. Productivity indices of Malmquist of provinces

DEA is employed to measure the indices of productivity of Malmquist. Compared with school production and the means used in 2004 and 2005, the results show that all the provinces made a positive change in technology of production since the minimum of the index FS is 1.0099 and the average is equal to 1.2516. The average index of TEC is equal to 1.0024; this im-

plies that the system through provinces had a technical efficiency profit in 2004 compared with 2005. The average of the index of productivity of Malmquist M is 1.2555. Twelve provinces saw a fall in technical efficiency, with index TEC<1. Among these provinces, 3 priority provinces on average made a loss in productivity primarily related to a loss in technical efficiency. The provinces which had the most important progressions in technology of production are Yagha, with FS=2.4856, Komandjari with FS=1.9748, Kadiogo with FS=1.6067, Oudalan with FS=1.5624, Gnagna with FS=1.5584.
Except for Kadiogo, where the capital city is situated, and which contains urban schools and many private schools, the other provinces presenting great benefits are priority provinces, i.e 20 provinces which had been defined as such in the "program for the development of basic education" by the government of Burkina Faso. These priority provinces are generally those which had around 1998 poor results in schooling, enrolment and gender parity. In those provinces, most of which are rural, demand for schooling is low and there is often a resistance to schooling for girls in particular. The state, by defining these priority provinces, plans to lead an educational policy of motivation and awareness towards girls in particular, by improving the school infrastructures: construction of schools and canteens; providing handbooks free of charge, in particular for the girls; motivating teachers by allocating resources so as to favor urban or semi-urban zones, etc.
The provinces indexed by (^{P}) are priority provinces for the development of basic education.
Comments: One can notice that among the 24 provinces that have a Malmquist index M superior to the median of data Q2=1.193, 10 are classified as priority (of the 20 priority, 50%). This may mean that the impact of the policy of discrimination in favor of priority is positive on the development of the education system in Burkina Faso. 6 of 11 have a Malmquist index M superior to third quartile Q3=1.28005 sign which is still binding as to the positive aspect of this policy. Note that the three highest Malmquist indices M are observed in the priority provinces.
In 2007-2008[2], already the priority provinces that have not had the same attention in 2005-2006 because their indicators were very positive indicators showed some decrease. For example, Yagha and Komandjari rates of schooling were respectively, 43.2 and 48.2 in 2005-2006 fell in 2007-2008 to 34.9 and 37.0 respectively.

7 Conclusion

DEA applied to two school years allowed to analyze the performances of the basic educational system in Burkina Faso. The two models used made it possible to observe the behavior of both technical and scale inefficiencies in the various provinces. This study showed that all the provinces (100%), during this period, saw a positive change in technology of production. As a result, it is possible to correlate performance profit in the provincial directions of basic teaching to the educational policy carried out during the same period. This policy managed by the program for the development of basic education, consists in increasing the resources to improve school results (schooling, enrolment, parity girl-boy, CPE success), on the one hand by recruiting and training teaching staff, building new schools and classrooms, on the other hand by opening new inspections in rural zones.

The results observed show a growth of approximately 4%, only the rates of CPE success saw a fall of approximately 6% on average. The increase in certain resources was not without consequence. Indeed, an important fall of the input factors was observed reflected in overpopulation in the classrooms, a shortage of certified teachers to supervise the pupils in the classrooms, as well as a back of teachers qualified for management and direction of the schools. The analysis of the sources of inefficiency shows that the inefficient provinces are mainly characterized by low rates of schooling, enrolment and CPE success. On the other hand, the results show uniformity in the use of the resources by the various provinces. To improve school outputs as a whole, it seems important to increase the number of: classrooms to prevent overpopulation; schools to increase the supply; inspection staffs (inspectors and/or education advisers) to improve the quality of control of both teachers and lessons; certified teachers to improve the quality of the lessons and of pupils' supervision, and particularly, CT or PT teachers to improve the quality of management of the schools.

This study is based on indicators of follow-up and evaluation of the development of the system of basic education defined in the PRSP. The data available by the ministry in charge of basic teaching made it possible to define the various input and output factors.

Finally, the inefficiency, characterized primarily by low outputs (rate of schooling, rate of enrolment, rate of CPE success) should be put in perspective with socio-economic, geographical, political factors, etc. It is the case for example, for the resistance of the population to schooling, the habits, accessibility of schools, the size, the economic weight of the area, and the socio-economic or socio-professional situation of the population in a given province.

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