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Assessment of efficiency in basic and secondary education in Tunisia: A regional analysis

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ABSTRACT

To determine the factors enhancing the efficiency of basic and secondary education in 24 governorates of Tunisia in 1999, 2003, 2006 and 2008, we apply a non-parametric approach, Data Envelopment Analysis (DEA) to multi-inputs and multi-outputs. Physical resources used in the study are: the number of classes per 100 students and the number of schools per million inhabitants. Human and financial resources are described by the number of teacher per 100 students and education spending per student respectively. The output measures include the success rate of baccalaureate exam and the rate of non-doubling in the 9th year. Our results show the absence of significant relationship between school resources and student performance. The output variable, non-doubling rate in the 9th year is the only factor able to influence the efficiency level of governorates in terms of 2nd cycle of basic education and secondary education. By regressing efficiency scores on non-discretionary variables, we find that inefficiency in education is strongly related to poverty within governorates.

1. Introduction

Economic recession and deterioration of the situation of the labour market in many countries are the essential basis of the evolution issues associated to education. It is important to recognize the role of education in stimulating economic growth and in the promotion of social development. As regards expenditure, the education sector absorbs a large share of the state budget in most countries. In some developing countries, despite the important financial effort in education, it still remains insufficient to reach the level of efficiency and to improve the quality of teaching activities provided to students. School resources have to be allocated within educational institutions and between governorates in a rational manner.

Therefore, each country seeks to achieve the level of efficiency in education, minimizing costs and resources used in this sector. To evaluate the degree of efficiency in education sector, it is important to analyse the connection between school inputs and student performance and outcomes (amount invested *versus* resulted obtained).

In this paper, we measure the efficiency in 2nd cycle of basic education and secondary education in 24 Tunisian governorates in 1999, 2003, 2006 and 2008.[1] The objective is to study the effect of school resources on student achievement and to determine the major influencing factor of basic and secondary education efficiency.

In methodological terms, we employ an output-oriented DEA model with constant returns to scale (CRS) and variable returns to scale (VRS) assumptions to assess the efficiency of decision making units (DMUs). We use four input variables describing human, material and financial resources (number of teacher per 100 students, number of classes per 100 students, number of schools per million inhabitants, and spending education per student) and two output variables describing student achievement: the success rate of the baccalaureate exam and the rate of non-doubling in the 9th year.

Our main results show the absence of a significant relation between school resources and the level of education efficiency in Tunisian governorates, where more resources do not directly improve efficiency. For instance, the non-doubling rate in the 9th

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[1] In 1999, only 23 governorates were introduced into the analysis because the governorate of Manouba was created in 2000.

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year is the only factor that seems relevant to increase the level of efficiency level of governorates in terms of 2nd cycle of basic education and secondary education.Moreover, a regional difference between the East region (North East and Centre East) and the other regions in terms of the 2nd cycle of basic education and secondary education efficiency is clearly evident from the efficiency scores results. In fact, a disparity of socio-economic characteristics among Tunisian regions and the insufficiency of school resources within the North West and South regions could be at the origin of these regional efficiency differences. In addition, using Tobit regressions, we show that efficiency in basic and secondary education is significantly influenced by employment and poverty.

The paper is organized as follows. In Section 2, we describe the Tunisian Education System and we present the framework of elementary, secondary and higher education in Tunisia. Section 3 corresponds to the review of the related existing literature on the effect of school resources on student performance and the methodology used in the paper. In Section 4, we proceed first to a description of the data used in the analysis, its evolution and the eventual patterns in the link between inputs and outputs by governorate. Secondly, we present the DEA results of efficiency and their explanation using non-discretionary inputs. Finally, Section 5 provides the conclusion.

2. Framework of elementary, secondary and higher education in Tunisia

The evolution in the level of Tunisian educated population over time is presented in Table 1.

The quantitative results taken from Table 1, demonstrate a general improvement in the level of education for the population aged 10 years and over. We observe a progress in the population with secondary and higher level of education and a reduction of the illiteracy rate.

The decrease noticed in the population with a primary level of education can be explained by the decrease in the new entrants to the primary cycle which passed from 199465 in 2000 to 162346 in 2004.[2]

The general improvement in the number of educated people aged 10 years and over in Tunisia reflects the double concern that characterize the Tunisian education policy: the control and the strict regulation in the number of students and the consecration of a sustainable financial effort reserved to education. Controlling the number of enrolled students allows the Tunisian government to have a control over its expenditure devoted to education sector. This process can be reinforced by the predominance of public education sector compared to private sector. The limited number of students accepted by the private educational institutions and the high cost of private sector (absence of public funding of private education) reduce the choice between private and public education for the students (Akkari, 2005).

The evolution of expenditure devoted to the three levels of education as percentage of total government expenditure is presented below in Table 2.

Compared to countries with similar economic situation, Tunisia procures a significant effort devoted to public education. To ensure quality education and to move from quantitative advances characterising the different levels of educational system to qualitative issues, this financial effort still remains insufficient and an efficiency measure of school resources' allocation seems to be necessary to achieve this goal. Internal inefficiency observed in Tunisian educational system is represented by the low quality of teaching and learning activities that characterized many educational institutions in primary, secondary and higher education.

Table 1
The level of education of the population aged 10 years and over (%).[7]

Level of instruction	2000	2001	2004	2014
Without education	24.9	24.1	23.5	19
Primary education	39.6	40.4	36.6	32.5
Secondary education	29.7	29.7	32.2	35
Higher Education	5.8	5.8	7.7	13

Sources: National study on population and employment: 2000 and 2001/National Institutes of statistics (INS, 2004 and 2014).

This problem can be viewed by the deterioration of academic achievement, the reduction of the number of students in different educational levels and the high levels of drop-out and repetition rates (Table 3).

In our analysis, we measure the efficiency of public secondary education and of the 2nd cycle of basic education in 24 Tunisian governorates in 1999, 2003, 2006 and 2008 through non-parametric Data Envelopment Analysis (DEA) approach. During this period, the overall number of teachers in public institutes of secondary education and pre-secondary schools in Tunisia increased around 96.6 percent and the number of teachers per 100 students increased from 4.7 in 1999 to 7.1 in 2008 (Ministry of Secondary Education). It should be noted also that the efficiency of education can positively influence the labour market in Tunisia in which the number of employed persons with secondary education has also increased nearly 4 percentage points ranging from 32 per cent in 2000 to 36.1 percent in 2007 (Source: Ministry of Employment, 2008) (Table 4).

3. Literature review

Enrolling students in schools providing a weak quality of education means an inefficient use of time and resources dedicated to education sector. Because allocation of school resources within schools and higher educational institutions should depend on the performance of individual educational establishments, it is necessary to perform a measurement of efficiency connecting school resources (human, materiel and financial resources) to student outcomes and achievement.

A large body of research appears after the publication of Coleman report (1966) to re-evaluate the connection between school resources and student achievement. The results generated from the diverse literature yield to a mixed conclusion about the relationship between school resources and student performance and outcomes.

Two different strands of literature regarding the issue of resources and student achievement exist. The first one deals with the absence of relationship between school resources and student performance (Coleman et al., 1966; Hanushek 1986, 1996; Coladarci and Cobb, 1996; Ruggiero and Vitaliano, 1999). The second one sheds lights on the significant effect and impact of school resources and environmental variables (pupil-teacher ratio, size of school, school expenditure, family characteristics) on educational outcomes (Kuziemko, 2006; Giorgio and Daniele, 2005; Essid et al., 2013; Kirjavainen and Loikkanent, 1998; Afonso and Aubyn, 2006; Lee and Barro, 2001; Ray, 1991; Greenwald et al., 1996).

Coleman et al. (1966) is the first group of researchers considering that higher levels of school resources like lower class sizes have no effect and influence on student achievement. Since

[2] Source: UNESCO Institute for statistics.

[7] For 2014, 0.5% (84357) of the population aged between 10 years and over is undeclared.

Table 2
Expenditure on the three levels of education as % of total government expenditure.

	2000	2001	2004	2008	2012
Expenditure on primary education as% of total government expenditure	8.34	8.28	9.78	7	–
Expenditure on secondary educations as% of total government expenditure	11.28	11.19	10.57	12	–
Expenditure on tertiary educations as% of total government expenditure	5.42	5.51	7.39	6.34	5.98
Expenditure on education as% of total government expenditure	25,05	24,97	27,74	25,35	21,25

Source: UNESCO Institute for Statistics.

Table 3
Number of students, success rate, and repetition and dropout rates in the three levels of education in Tunisia.

	Primary education			Secondary education			Tertiary education		
	2011	2012	2013	2011	2012	2013	2011	2012	2013
Number of students	1014836	1029559	1049177	922458	908600	887445	339619	315513	305783
Success rate/Number of graduates	91,5	92,2	91,9	71,7	72	72	74133	68880	61376
Repetition rate	7,5	6,7	7,1	17,1	16,4	16,6	–	–	–
Drop-out rate	1	1,1	1	11,1	11,6	11,4	–	–	–

Source: Ministry of education/Ministry of higher education and scientific research.

Table 4
Output oriented DEA model under CRS and VRS assumptions.

Output oriented	
CRS assumption (CCR model)	VRS assumption (BCC model)
$\frac{1}{e_0} = max\theta_0 + \varepsilon\sum_{i=1}^{m} s_i^- + \varepsilon\sum_{r=1}^{t} s_r^+$	$\frac{1}{e_0} = max\theta_0 + \varepsilon\sum_{i=1}^{m} s_i^- + \varepsilon\sum_{r=1}^{t} s_r^+$
$\sum_{j=1}^{n}\lambda_j x_{ij} + s_i^- = x_{ij_0}, \forall i$	$\sum_{j=1}^{n}\lambda_j x_{ij} + s_i^- = x_{ij_0}, \forall i$
$\theta_0 y_{rj_0} - \sum_{j=1}^{n}\lambda_j y_{rj} + s_r^+ = 0 \forall r$	$\theta_0 y_{rj_0} - \sum_{j=1}^{n}\lambda_j y_{rj} + s_r^+ = 0 \forall r$
$\lambda_j, s_i^-, s_r^+ \geq 0 \forall j, r, i$	$\sum_{j=1}^{n}\lambda_j = 1$
	$\lambda_j, s_i^-, s_r^+ \geq 0 \forall j, r, i$

the Coleman report, much of the subsequent literature has shared the same idea on the absence of relationship connecting school resources to student performance.

Hanushek (1986) have published a research study on the economics of education and schooling focusing on production and efficiency aspects of educational institutions (schools). He concludes from this study the absence of a significant relation between school resources (school expenditure) and student achievement, 'There appears to be no strong or systematic relationship between school expenditure and student performance'.

According to Hanushek (1996), spending and resources allocated to schools, don't provide an important measure of education quality. Adding more resources and amount of money spent to the production process is unlikely to provide improvement in student's educational attainment. Differences and variation in resources are not related to student performance and educational outcomes.

Coladarci and Cobb (1996) conducted bivariate and multivariate analyses to a sample of America's high schools composed by 3.317 small school students and 2.992 larger school students in order to examine the indirect effect of school size on self-esteem and academic achievement. Studying the relationship between school size and extracurricular participation in high school, results demonstrate that students attending smaller high schools are characterized by greater EP (extracurricular participation) than did students enrolled in larger high schools. In spite of that, there is a negligible effect of EP on academic achievement while the effect on self-esteem is significant.

Ruggiero and Vitaliano (1999) have analysed the cost efficiency of 520 American school districts using DEA approach and stochastic frontier regression. They conclude that higher teacher salaries are strongly associated with less efficient schools which reflect a negligible influence of scholar resources on schools' efficiency.

Research works belonging to the second branch of the literature argue the significant effect of school resources and socio-economic variables on student attainment and achievement. In this context, Kuziemko (2006) employs school-level panel data for elementary schools in Indiana between 1989 and 1998 to examine the effect of enrolment size on achievement. The analyses demonstrate negative effect of enrolment increases on student achievement. The author argues that reducing school size increases student achievement measured by average daily attendance and standardized math scores.

Giorgio and Daniele (2005) studied the effect of school quality measured by pupil-teacher ratio on educational attainment and labour market returns of a sample of Italians born between 1941 and 1970 using ordered Probit and OLS estimates. They conclude that reduction in pupil-teacher ratio and the increase in parental education had a significant effect on educational attainment and labour market returns.

Essid et al. (2013) apply a bootstrap methodology to a sample of 332 Tunisian high schools in order to determine the optimal size of educational institution based on assessing scale characterizations that schools need to have, to profit from the scale efficiency. They argue a correlation between schools' size and returns to scale characterizations. The results of analyses show the existence of significant relationship between high school sizes and scale efficiency scores. The highest concentration of scale-efficient schools characterizes only medium and large size schools. According to them the size of schools has an important effect on its efficiency. The improvement of the Tunisian education efficiency system is largely related to medium and large size schools.

School environment and social-economic background can be used to differentiate between students' performance level and schools' efficiency. Kirjavainen and Loikkanent (1998) measured the efficiency of 291 Finnish secondary schools from 1988 to 1991 using DEA method. They aim to analyse the influence of input

variables on the efficiency scores under VRS and CRS assumptions. They conclude that incorporation of qualitative variables into DEA model demonstrates that parents' educational level improves the efficiency of schools.

Afonso and Aubyn (2006) studied the efficiency of secondary education in 25 OECD countries by estimating a semi-parametric model of the education production process using a two-stage approach. They incorporate non-discretionary inputs into Tobit analysis in order to detect to sources of inefficiency. The results show a negative relationship linking variables beyond the control of governments and efficiency scores of the secondary educational system. They found that inefficiency is strongly related to family economic background (GDP per capita) and the education of parents.

Lee and Barro (2001) investigated the determinants of educational outcomes in 85 countries by analysing the relationship between input variables (family characteristics: income and parent education and school resources: pupil-teacher ratios, public educational spending per student . . .) and student performance measured by test scores, school repetition and dropout rates. They indicated that family inputs have a strong effect on student performance. They found that educational outcomes can be improved by more school resources.

Ray (1991) combined DEA method with regression analysis to evaluate the efficiency of 122districts operating high schools in Connecticut during 1980–81. The use of non-discretionary inputs in second-stage regression model allows the conclusion that differences in schools' efficiency vary systematically with socio-economic characteristics of towns.

A summary of studies dealing with the topic of relationship between school resources and education outcomes has been introduced by Greenwald et al. (1996). They report the results of a broad number of research studies using *meta*-analytic methods to evaluate the direction and magnitude of school inputs' effect on student achievement while controlling for student or family background. Diverse literature reports mixed conclusion about the linking between school inputs and student outcomes. The most conscientious analysis indicates that a large range of school inputs are positively connected to student outcomes. The general result generated from the *meta*-analysis indicates the existence of a systematic relation between school resources and student achievement. A small schools and classes' size affects positively student achievement and PPE variable (Per–Pupil expenditure) demonstrates an important relation with achievement. They argue that indicators describing teachers' quality (teacher education, teacher ability and experience) show a strong link with student achievement.

3.1. Analytical framework

Data Envelopment Analysis (DEA) model is a non-parametric mathematical programming method proposed by Farrell (1957) and developed by Charnes et al. (1978). It is used to evaluate the efficiency of homogenous organisations called Decision Making Units (DMUs) operating in non-profit sectors such as (schools, Hospitals, Universities, Banks . . .). They use multiple and identical input variables to produce the same outputs. All the observed input and output variables are used by DEA to form the production possibility frontier. The efficiency of each DMU relative to all others DMUs is calculated based on its deviation from the efficiency frontier composed by the best practices units. A DMU is considered as inefficient if it is located below the efficiency frontier and its efficiency score is less than one. To reach efficiency frontier, inefficient units could either increase some amounts of outputs produced (or decrease some quantities of inputs used during the production process) without worsening the other inputs or outputs.

Measuring the output efficiency of a DMU consists on the calculation of the amount of output that can be increased without the necessity to increase the inputs used (output oriented DEA model). While input orientation approach consists on the measure of the quantity of inputs reduced during the production process maintaining the same amount of the output produced.

To evaluate educational achievement of students and the efficiency of 2nd cycle of basic education and secondary education in 24 Tunisia governorates in 1999, 2003, 2006 and 2008, we have conducted an output oriented DEA model under CRS assumption (CCR model) and VRS assumption (BCC model) using MES (Measurement Efficiency System) software version 1.3.0 developed by Holger Scheel. With CRS assumption, there is not a significant relation between the scale of operations and efficiency level of DMUs. It means that the quantity of outputs produced, increases in the same proportions as the increase of the quantities of inputs. In other words, big governorates are not considered as more efficient than smaller ones in transforming their school resources to outputs. On the other hand, under variable returns to scale, an increase in the amount of inputs leads to a disproportionate growth in the quantity of output produced by DMUs due to decreasing marginal returns.

The purpose of the study is to assess the relationship between school resources and student achievement and to evaluate how much the output quantities can be proportionally increased without modifying the amount of inputs consumed in 2nd cycle of basic education and secondary education sub-sectors. Analysing the efficiency use of school resources is important to detect factors improving students' achievement and enhancing the level of education efficiency. The advantage of applying DEA approach is that it identifies for each inefficient unit a set of efficient units called "Peers". These include efficient units if they are evaluated with an optimal system of weights. These DMUs are asked to learn inefficient governorates how to transform inputs to outputs to become efficient. In other words, inefficient governorates should follow their peers' strategy and adopt their techniques and practices in order to reach the efficiency frontier. The analysis of 'peers' group can differentiate between DMUs that are really efficient and others that are efficient by default. We present below, the analytical description of the linear programming problem to be solved, from an output oriented perspective under the assumptions of constant returns to scale (CRS) and variable returns to scale (VRS).

Suppose that we have for n DMUs, where each DMU_j, $j = 1,\ldots,n$ uses the same m inputs, $x_{ij}(i = 1,2,\ldots,m)$ in different amounts, to produce the same t outputs in (possibly) different quantities, $y_{rj}(r = 1,2,\ldots,t)$.

As can be seen, the formulation of an output oriented DEA under variable returns to scale (VRS) assumption is marked by the addition of the convexity constraint $\sum_{j=1}^{n}\lambda_j = 1$ compared to the "envelopment form" of the model with constant returns to scale assumption (CRS). Dropping of this constraint makes the returns to scale constant (see, for instance, Coelli, 1996).

4. Data description and DEA results of efficiency

4.1. Data description

The choice and the selection of input and output variables hold a considerable importance in the estimation of DEA model. They depend on the purpose of the efficiency evaluation aimed by the author. Through this study, we aim to analyse the effect of school

resources on student achievement in 24 Tunisian governorates and to detect the principal factor influencing the efficiency of 2nd cycle of basic education and secondary education in Tunisia.

As we know, student success is at the heart of schools' effectiveness and state mission. In our case, we use two output variables measuring student achievement: the success rate of baccalaureate exam and the rate of non-doubling in the 9th year. We have chosen these two rates as proxies for efficiency in Tunisian education because the two exams of the 9th year and the baccalaureate permit the transition of students from one cycle to another.

Input variables used in DEA efficiency measurement are composed by resources describing schools quality (number of teachers/100 students and number of classes/100 students), financial resources (education spending per student) and a measure of educational characteristic related to governorates (number of schools per million inhabitants).[3] The evolution of the average data of 24 governorates over the period of study is described below in Fig. 1.

The curves describing the evolution of averaging data in Fig. 1 show that:

–The two indicators of school quality, the number of teacher per 100 students and the number of classes per 100 students vary in the same direction with similar intensities.

–The evolution of education spending per students is characterised by a continuous growth from 1999 to 2003 with a peak in 2003. This peak was followed by a continued decrease from 2006 to 2008.

–The number of schools per million inhabitants was marked by a continuous and significant increase in 1999, 2003, 2006 and 2008. It passed from 115 schools in 1999–143 schools in 2008.

–The rates of non-doubling in the 9th year and the success rate of baccalaureate exam have experienced an increase from 1999 to reach a peak in 2003. From this date, the success rate of baccalaureate exam has decreased until 2006 to increase again by 6.5% in 2008. While the rate of non-doubling in the 9th year showed a slight decrease between 2003 and 2006 followed by a slow growth until 2008.

In Fig. A1 (Appendix A), we report the plot of a measure of student achievement, given by the output variables, success rate of baccalaureate exam and the rate of non-doubling in the 9th year and a measure of school resources, given by the input variables, number of teacher per 100 students, number of classes per 100 students, number of schools per million inhabitants and education spending per student.[4]

Based on the scatter plot and the calculation of Pearson correlation coefficient (Appendix B), we can draw several conclusions:

–The existence of a negative linear relationship of a very weak strength between the success rate on baccalaureate exam and the two input variables number of teacher per 100 students and number of classes per 100 students.[5]

–Absence of correlation between the rate of non-doubling in the 9th year and the two inputs, number of teacher per 100 students and education spending per student.

–A negative linear relationship of a weak strength between education spending per student and the success rate in baccalaureate exam.

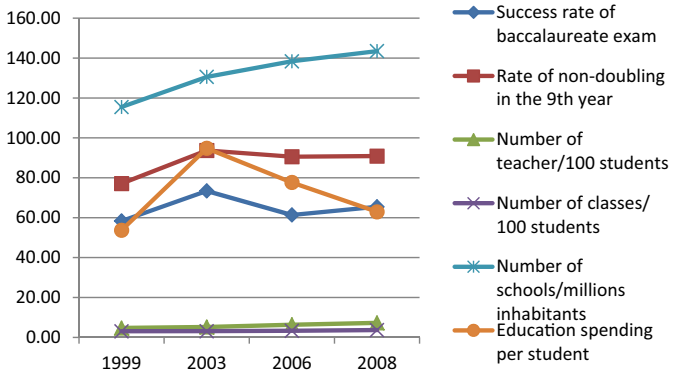


Fig. 1. Evolution of averaging data over the study period.
Source: Tunisian Ministry of education.

–A negative linear relationship of a weak strength between the number of schools per million inhabitants and the rate of non-doubling in the 9th year.

4.2. DEA results of efficiency

Table 5 shows, the efficiency scores estimated with an output-oriented CRS DEA model (CCR model) and the reference sets (peers) for each inefficient DMU in 1999, 2003, 2006 and 2008. From the results, we see that in 1999, empirical production function contains three efficient DMUs (the governorates of Tunis, Sfax and Nabeul). The average output efficient score of all governorates equals 0.86, which indicates that with the same level of inputs used, the average DMU seems obtaining a performance about 14% less than it should if it was on the efficiency frontier. The lowest efficiency score of 74% is attributed to the governorate of Sidi Bouzid. It explains that with the same quantity of inputs, this governorate seems to be obtaining efficiency about 26% less than it should if it was on the production possibility frontier. To become efficient, the governorate of Sidi Bouzid should learn best practices from the governorate of Sfax which is considered as most recurring peer in 1999. The governorate of Sfax was referenced 20 times, which means that there are 20 inefficient governorates which should learn from DMU $_{19}$ best practices and policies to become efficient.

In 2003, the efficiency frontier is composed by 9 efficient governorates (Tunis, Manouba, Bizerte, Gafsa, Tataouine, Sfax, Kairouan, Monastir and Nabeul). The average output efficient score equals 0.97, which means that with the same inputs, the average DMU seems obtaining a performance about 3% less than it should if it was on the efficiency frontier. The lowest efficiency score of 92% is attributed to the governorate of Zaghouan which is referenced by the two DMUs of Gafsa and Kairouan with weights of (0,9) and (0,2) respectively. Therefore, it is observed that the most recurring peer in 2003 is the governorate of Gafsa. It was referenced for 14 times while the three efficient governorates of Manouba, Tataouine and Monastir don't constitute a reference for any inefficient DMU. They are considered as efficient by default.

In 2006, the governorates of Ben Arous, Sfax and Nabeul are considered as reference sets for inefficient DMUs. The average efficiency score is about 92%, which means that with the same level of inputs consumed, the average DMU seems obtaining a performance about 8% less than it should if it was on the efficiency frontier. The lowest efficiency score of 81% is attributed to the governorate of Tozeur, and it peer is the governorate of Ben Arous with a weight of 1,1 to become efficient. Further, it is observed that

[3] Education spending/student do not include teacher's salaries.
[4] We used the average data between 2003, 2006 and 2008 because in 1999, the governorate of Manouba had not yet been established.
[5] Pearson correlation coefficient: $r < 0.3$ and p-value > 0.05 (Appendix B).

Table 5
CCR results and peers.

Governorates	1999		2003		2006		2008	
	Efficiency scores	Peers	Efficiency scores	Peers	Efficiency scores	Peers	Efficiency scores	Peers
1-Tunis	1	1	1	3	0,99	4 (0,6) 19 (0,4)	1	13
2-Ariana	0,88	19 (1,0)	0,98	1 (0,1) 19 (0,1) 24 (0,8)	0,97	19 (0,1) 24 (0,9)	0,98	1 (0,3) 24 (0,7)
3-Manouba	–	–	1	0	0,96	4 (0,8) 24 (0,2)	0.99	1 (0,6) 24 (0,5)
4-Ben Arous	0,92	19 (1,0)	0.99	13 (0,3) 21 (0,1) 24 (0,5)	1	19	1	6
5-Zaghouan	0,78	19 (1,0)	0,92	13 (0,9) 21 (0,2)	0,89	4 (1,1)	0,91	4 (1,1)
6-Bizerte	0,91	19 (1,0)	1	2	0,98	4 (1,0)	0,99	4 (0,1) 24 (1,0)
7-Beja	0,77	19 (1,1)	0,94	13 (0,7) 21 (0,2) 24 (0,1)	0,90	4 (1,1)	0,92	1 (0,1) 24 (1,0)
8-Jendouba	0,80	19 (1,0)	0,95	13 (0,2) 21 (0,2) 24 (0,6)	0,88	4 (1,1) 24 (0,0)	0,92	1 (0,1) 24 (1,0)
9-Siliana	0,78	19 (1,0)	0,95	13 (0,7) 21 (0,3)	0,86	4 (1,1) 19 (0,0)	0,89	4 (1,1)
10-Le Kef	0,78	19 (1,0)	0,94	13 (0,5) 19 (0,1) 24 (0,5)	0,90	4 (1,1)	0,92	1 (0,3) 24 (0,8)
11-Kasserine	0,81	19 (1,0)	0,99	13 (0,3) 21 (0,5) 24 (0,2)	0,94	4 (1,0)	0,95	4 (1,1)
12-Sidi Bouzid	0,74	19 (1,0)	0,99	13 (0,7) 21 (0,4)	0,95	4 (1,1)	0,92	1 (0,5) 24 (0,6)
13-Gafsa	0,78	19 (1,0)	1	14	0,92	4 (1,0)	0,92	1 (0,3) 24 (0,8)
14-Tozeur	0,75	19 (1,1)	0,93	1 (0,3) 6 (0,6) 13 (0,2)	0,81	4 (1,1)	0,86	1 (1,2)
15-kebili	0,83	19 (1,0)	0,96	13 (0,4) 19 (0,6)	0,82	4 (1,1)	0,86	1 (1,1)
16-Tataouine	0,89	19 (1,0)	1	0	0,88	4 (1,1)	0,89	1 (0,9) 24 (0,2)
17-Medenine	0,91	19 (1,0)	0.99	13 (0,4) 19 (0,6)	0,99	4 (0,8) 19 (0,2)	0,91	1 (1,1)
18-Gabes	0,87	19 (1,0)	0,99	13 (0,6) 19 (0,4) 24 (0,1)	0,90	4 (1,0) 24 (0,0)	0,89	1 (0,0) 24 (1,1)
19-Sfax	1	20	1	7	1	8	1	1
20-Mahdia	0,88	19 (1,1)	0,95	6 (0,1) 13 (0,2) 19 (0,4) 24 (0,3)	0,91	4 (0,6) 19 (0,5)	0,87	4 (1,0) 24 (0,2)
21-Kairouan	0,87	19 (0,9) 24 (0,1)	1	7	0,93	4 (1,0) 19 (0,1)	0,95	4 (0,1) 24 (0,9)
22-Monastir	0,92	1 (0,5) 19(0,5)	1	0	0,92	4 (0,4) 19 (0,7)	0,95	19 (0,1) 24 (0,9)
23-Sousse	0,94	19 (1,0)	0,98	1 (0,5) 13 (0,1) 19 (0,3) 24 (0,1)	0,99	19 (0,4) 24 (0,6)	0.99	1 (0,1) 24 (0,9)
24-Nabeul	1	1	1	9	1	5	1	14
Mean	0,86		0,97		0,92		0,93	

the governorate of Ben Arous (DMU_4) is the most recurring peer. It was referenced for 19 times which means that it was considered as reference for 19 inefficient governorates.

In 2008, the four governorates of Tunis, Ben Arous, Sfax and Nabeul are considered as efficient. The average efficiency score equals 0.93 which means that with the same level of inputs used, the average DMU seems to be obtaining a performance about 7% less than it should if it was on the efficiency frontier. The two governorates of Tozeur and Kebili are ranked the last with efficiency scores of 86% and they are referenced by the same DMU (governorate of Tunis) with weights of (1,2) and (1,1) respectively. The most recurring DMU is the governorate of Nabeul which was referenced for 14 times in 2008.

Table 6 shows the efficiency scores estimated with an output oriented VRS DEA model (BCC model) and reference sets (peers) for each inefficient DMU in 1999, 2003, 2006 and 2008.

In 1999, the efficiency frontier is composed by four efficient governorates (Tunis, Ben Arous, Sfax and Nabeul). The average

Table 6
Efficiency scores and peers estimated with an output-oriented VRS DEA model.

Governorates	1999		2003		2006		2008	
	Efficiency scores	Peers	Efficiency scores	Peers	Efficiency scores	Peers	Efficiency scores	Peers
1-Tunis	1	1	1	0	1	0	1	0
2-Ariana	0.89	19(1,0)	0,99	10 (0,0) 19 (0,1) 24 (0,8)	0,98	4 (0,2) 19 (0,3) 24 (0,5)	0,98	3 (0,0) 23 (0,4) 24 (0,6)
3-Manouba	–	–	1	0	0,99	4 (0,9) 24 (0,1)	1	1
4-Ben Arous	1	4	1	0	1	15	1	0
5-Zaghouan	0,79	19 (1,0)	0,98	10 (1,0)	0,98	10 (0,4) 12 (0,6)	1	13
6-Bizerte	0,95	4 (0,6) 19 (0,4)	1	0	0,99	4 (0,8) 12 (0,2)	0.99	23 (1,0)
7-Beja	0,81	19 (1,0)	0,99	10 (0,8) 12 (0,0) 13 (0,0) 21 (0,1)	0,99	4 (0,3) 10 (0,7) 19 (0,0)	0,99	5 (0,6) 20 (0,0) 23 (0,4)
8-Jendouba	0,80	19 (1,0)	0,99	10 (0,4) 24 (0,6)	0,96	4 (0,8) 12 (0,2)	0,99	5 (0,0) 23 (1,0)
9-Siliana	0,81	19 (1,0)	0,99	10 (0,5) 12 (0,5) 16 (0,0)	0,97	4 (0,3) 10 (0,6) 19 (0,2)	0,98	5 (0,5) 20 (0,3) 23 (0,2)
10-Le Kef	0,81	19 (1,0)	1	10	1	9	0,99	5 (0,6) 20 (0,0) 23 (0,4)
11-Kasserine	0,82	4 (0,1) 19 (0,9)	0.99	12 (0,4) 13 (0,1) 21 (0,1) 24 (0,4)	0,98	4 (0,6) 12 (0,4)	0,98	5 (0,2) 23 (0,8)
12-Sidi Bouzid	0,74	19 (1,0)	1	3	1	6	0,97	5 (0,4) 23 (0,6)
13-Gafsa	0,78	19 (1,0)	1	5	0,94	4 (0,5) 12 (0,5)	0,94	5 (0,2) 20 (0,0) 23 (0,8)
14-Tozeur	0,79	19 (1,0)	0.99	10 (0,6) 22 (0,4)	0,92	10 (1,0)	0,99	5 (0,4) 20 (0,6)
15-kebili	0,85	19 (1,0)	0,97	10 (0,1) 13 (0,3) 19 (0,6)	0,91	4 (0,6) 12 (0,4)	0,95	5 (0,1) 20 (0,5) 23 (0,3)
16-Tataouine	0,92	19 (1,0)	1	2	0,95	4 (0,4) 10 (0,6) 19 (0,0)	0,95	5 (0,6) 20 (0,0) 23 (0,4)
17-Medenine	0,99	4 (0,3) 19 (0,7)	1	0	1	0	0,96	5 (0,2) 20 (0,2) 23 (0,7)
18-Gabes	0,88	19 (1,0)	0,99	10 (0,0) 13 (0,5) 16 (0,0) 19 (0,4)	0,96	4 (0,3) 10 (0,5) 19 (0,2)	0,96	5 (0,4) 20 (0,2) 23 (0,4)
19-Sfax	1	19	1	5	1	9	1	1
20-Mahdia	0,93	19 (1,0)	0,98	10 (0,4) 19 (0,3) 22 (0,0) 24 (0,3)	0.99	4 (0,1) 10 (0,4) 19 (0,5)	1	11
21-Kairouan	0,90	4 (0,2) 19(0,4) 24 (0,4)	1	2	0,97	4 (0,7) 10 (0,2) 19 (0,1)	0,98	5 (0,0) 20 (0,2) 23 (0,8)
22-Monastir	0,95	1 (0,4) 19 (0,6)	1	2	0,97	4 (0,3) 10 (0,1) 19 (0,7)	0,99	19 (0,4) 20 (0,2) 23 (0,5)
23-Sousse	0,97	19 (1,0)	0,99	10 (0,2) 13 (0,1) 19 (0,3) 24 (0,4)	0,99	4 (0,3) 19 (0,6) 24 (0,1)	1	15
24-Nabeul	1	1	1	5	1	3	1	1
Mean	0,84		0,99		0,97		0,98	

output efficient score equals 0.84 which explains that with the same level of inputs, the average DMU seems obtaining a performance about 16% less than it should if it was in the efficiency frontier. The lowest efficiency frontier of 74% is attributed to the governorate of Sidi Bouzid (same results as CCR model) which is referenced by governorate of Sfax (DMU_{19}) with weight of 1,0. The most recurring peer in 1999 is the governorate of Sfax which is referenced for 19 times.

In 2003, 13 governorates of 24 are marked as efficient (Tunis, Manouba, Ben Arous, Bizerte, Kef, Sidi Bouzid, Gafsa, Tataouine, Medenine, Sfax, Kairouan, Monastir and Nabeul). Among them, the governorates of Tunis, Manouba, Ben Arous, Bizerte and Medenine

are considered as efficient by default (they don't constitute reference for any inefficient DMU). The average efficiency score is about 0.99 which means that with the same level of inputs, the average DMU seems obtaining a performance about 1% less than it should if it was on the efficiency frontier. The lowest efficiency score is attributed to the governorate of Kebili but the most recurring DMU is the governorate of Kef which was referenced for 10 times.

In 2006, we see that empirical production function is constituted by 7 efficient governorates (Tunis, Ben Arous, Kef, Sidi Bouzid, Medenine, Sfax and Nabeul). From them, the two governorates of Tunis and Medenine are efficient by default. The average of output efficient score equals 97%, which means that with the same level of inputs, the average DMU seems obtaining a performance about 3% less than it should if it was on the efficiency frontier. The lowest efficiency score of 91% is attributed to the governorate of Kebili. The governorate of Ben Arous is considered as the most recurring peer. It constitutes a reference set for 15 inefficient governorates that should follow it and adopt its practices to become efficient.

In 2008, the efficiency frontier is composed by the governorates of Manouba, Zaghouan, Sfax, Mahdia, Sousse and Nabeul while the governorates of Tunis and Ben Arous are considered as efficient by default. The average efficiency score is about 98% which demonstrates that with the same level of inputs, the average DMU seems obtaining a performance about 2% less than it should if it was on the efficiency frontier. The lowest efficiency score of 94% is attributed to the governorate of Gafsa. To become efficient, this governorate should learn best practices from the three governorates of Zaghouan, Mahdia and Sousse with weights of (0,2), (0,0) and (0,8) respectively. The most recurring peer in 2008 is the governorate of Sousse which was referenced for 15 times.

We can see from the results in Tables 5 and 6, that the most recurring peers considered as references for inefficient DMUs, generally belong to North East region (the governorate of Ben Arous) and Centre East region (governorates of Sfax, Nabeul and Sousse).

From the averaging data between 2003, 2006 and 2008 we establish in Table 7 an arrangement of governorates in two groups according to their efficiency scores compared to the average efficiency of 24 governorates estimated with an output-oriented VRS DEA model. The first group includes the governorates in which their efficiency sores are below the average output efficient score (0.99). The second group includes the governorates in which their efficiency scores equal or above the average output efficient score. The results show clearly a regional imbalance between East region (North East and Centre East) and the other regions in terms of efficiency in 2nd cycle of basic education and secondary education in Tunisia. Efficient governorates are those belonging to North East and Centre East regions. The only DMU of North West region considered as efficient is the governorate of Kef. The governorates classified in the first group whose efficiency scores are below the average output efficient score belong to North West and South regions. Most governorates whose efficiency scores equal to the average output efficient score are those of Centre West region (Kairouan, Kasserine and Sidi Bouzid).

This lack of regional balance in terms of efficiency in 2nd cycle of basic education and secondary education in Tunisia can be due to a disparity of socioeconomic characteristics between East region (North East and Centre East) and the other regions of the country. The misallocation of material and financial school resources between the regions and the lack of teachers' competitiveness in disadvantaged regions could explain the regional imbalance. Regional development index in Tunisia demonstrates the existence of significant regional disparities between East region (North East and Centre East) and the other regions of the country considered as the poorest and the least developed in Tunisia (Fig. 2).

In order to study the effect of input and output variables on the efficiency of 2nd cycle of basic education and secondary education, we have conducted different models specifications by subtracting/adding each time every input/output based on the averaging data between 2003 and 2006 and 2008. Then we have compared the efficiency estimates of different models using the non-parametric test of Mann-Whitney. The results from Table 8 studying the

Table 7
Arrangement of governorates according to their efficiency scores compared to the average efficiency estimated with BCC model (Averaging data 2003–2006–2008).

		Governorates	Efficiency scores
Governorates with efficiency scores below the average output efficient score		Jendouba	0,98
		Siliana	0,98
		Gafsa	0,97
		Tozeur	0,97
		Kebili	0,94
		Tataouine	0,98
		Medenine	0,97
		Gabes	0,98
	Efficient governorates	Tunis	1
		Ariana	1
		Monastir	1
		BenArous	1
Governorates with efficiency scores similar or above the average output efficient score.		Zaghouan	1
		Bizerte	1
		Sfax	1
		Mahdia	1
		Manouba	1
		Nabeul	1
		Kef	1
	Governorates with efficiency scores equal to the average output efficient score	Beja	0,99
		Kasserine	0,99
		Kairouan	0,99
		Sidi Bouzid	0,99
		Sousse	0,99

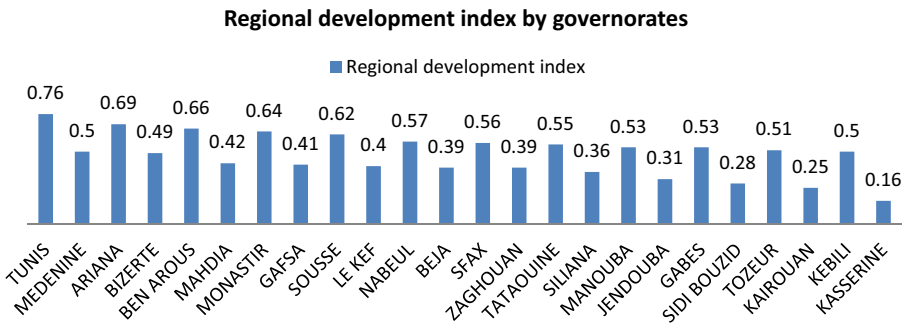


Fig. 2. Regional development index by Tunisian governorates.
Source: Ministry of regional development and planning, November 2012.

Table 8
Effect of input variables on the efficiency of governorates.

	Number of teachers/100 students		Number of classes/100 students		Number of schools per million inhabitants		Education spending per student	
	–	+	–	+	–	+	–	+
1-Tunis	1	1	1	1	1	1	0,99	1
2-Ariana	1	1	0,99	1	1	1	1	1
3-Manouba	1	1	0.99	1	1	1	1	1
4-Ben Arous	1	1	1	1	1	1	1	1
5-Zaghouan	1	1	1	1	1	1	1	1
6-Bizerte	1	1	0,99	1	1	1	1	1
7-Beja	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99
8-Jendouba	0,98	0,98	0,98	0,98	0,97	0,98	0,98	0,98
9-Siliana	0,98	0,98	0,98	0,98	0,98	0,98	0,98	0,98
10-Le Kef	1	1	1	1	1	1	1	1
11-Kasserine	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99
12-Sidi Bouzid	0,99	0,99	0.99	0,99	0,99	0,99	0,99	0,99
13-Gafsa	0,98	0,98	0,97	0,98	0,98	0,98	0,98	0,98
14-Tozeur	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97
15-kebili	0,94	0,94	0,94	0,94	0,94	0,94	0,94	0,94
16-Tataouine	0,98	0,98	0,97	0,98	0,98	0,98	0,98	0,98
17-Medenine	0,97	0,97	0,97	0,97	0,97	0,97	0,97	0,97
18-Gabes	0,98	0,98	0,98	0,98	0,98	0,98	0,98	0,98
19-Sfax	1	1	1,	1	1	1	1	1
20-Mahdia	1	1	1	1	1	1	1	1
21-Kairouan	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99
22-Monastir	1	1	1	1	1	1	0,99	1
23-Sousse	0,99	0,99	0,99	0,99	0,99	0,99	0,99	0,99
24-Nabeul	1	1	1	1	1	1	1	1
Average	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99
Mann-Whitney Test (Alpha:0.05)								
U	288,000		257,000		284,500		272,000	
Expectation	288,000		288,000		288,000		288,000	
Variance	2082,383		2144,681		2086,851		2123,234	
P value	1,000		0,510		0,948		0,737	

importance of input variables on the efficiency of 2nd cycle of basic education and secondary education, demonstrate the absence of significant effect of input variables on the efficiency of education (P-value of Mann-Whitney test is higher than alpha (0.05) for all models with different inputs specifications). School resources used in this paper have no effect and influence on the efficiency of governorates in terms of 2nd cycle of basic education and secondary education which confirms the results of Hanushek, 1986, 1996; Coleman et al. (1966).

The results from Table 9, studying the importance of outputs on the efficiency of 2nd cycle of basic education and secondary education, demonstrate the important effect of the non-doubling rate in the 9th year on the efficiency of education (P-value < 0.05). The success rate of baccalaureate exam has no influence on the efficiency level of education. We can conclude that increasing the non-doubling rate in the 9th year could ameliorate the efficiency of Tunisian governorates in terms of 2nd cycle of basic education and secondary education.

4.3. Explaining efficiency – non-discretionary inputs

Using DEA efficiency scores estimated in Table 6 for 2008, we evaluate in this section the importance of non-discretioanry inputs in explaning the level of governments' efficiency. For this purpose,

Table 9
Effect of output variables on the efficiency of governorates.

	Success Rate in baccalaureate exam		Non-doubling rate in 9th year	
	–	+	–	+
1-Tunis	0,99	1	1	1
2-Ariana	0,99	1	1	1
3-Manouba	1	1	0,85	1
4-Ben Arous	1	1	1	1
5-Zaghouan	1	1	0,74	1
6-Bizerte	1	1	0,92	1
7-Beja	0,99	0,99	0,76	0,99
8-Jendouba	0,98	0,98	0,68	0,98
9-Siliana	0,98	0,98	0,79	0,98
10-Le Kef	1	1	0,79	1,00
11-Kasserine	0,99	0,99	0,78	0,99
12-Sidi Bouzid	0,99	0,99	0,75	0,99
13-Gafsa	0,98	0,98	0,79	0,98
14-Tozeur	0,97	0,97	0,76	0,97
15-kebili	0,94	0,94	0,76	0,94
16-Tataouine	0,98	0,98	0,78	0,98
17-Medenine	0,97	0,97	0,88	0,97
18-Gabes	0,98	0,98	0,83	0,98
19-Sfax	0,99	1	1	1
20-Mahdia	0,99	1	0,90	1
21-Kairouan	0,99	0,99	0,85	0,99
22-Monastir	0,99	1	1	1
23-Sousse	0,99	0,99	0,97	0,99
24-Nabeul	1	1	1	1
Average	0.99	0.99	0.86	0.99
Mann-Whitney Test (Alpha:0.05)				
U	2468,000		107,000	
Expectation	288,000		288,000	
Variance	2153,872		2201,617	
P value	0,395		0,000	

Table 10
Explaining efficiency.

	Model 1	Model 2
Constant	0.953834	0.954066
	(0.000)	(0.000)
E	0.0.000581	0.000569
	(0.0782)	(0.1423)
P	−0.001066	−0.001046
	(0.0968)	(0.1494)
Y		1.77E-07
		(0.9522)
$\hat{\sigma}_\varepsilon$	0.017189	0.017704

Notes: E – employment; P – extreme poverty; Y – GDP per capita. $\hat{\sigma}_\varepsilon$ – estimated standard deviation of ε. P- values in brackets.

we employ the regression technique (Tobit) consisting on regressing the data envelopment analysis output scores on non-discretionary inputs. In this case, the efficiency scores ($\hat{\delta}$) are regressed on the employment rate (E), and on the rate of extreme poverty (P), using as demonstrated by the constraint below[6]:

$$\hat{\delta}_i = \beta_0 + \beta_1 E_i + \beta_2 P_i + \varepsilon_i.$$

We report in Table 10 the results estimated from Tobit regessions for two alternative specifications (Model 1: employment and extreme poverty are the non-discretionary variables used in the analysis) and (Model 2: employment, extreme poverty and GDP per capita are the non-discretionary variables used). It is clearly shown from the results that inefficiency in basic and secondary education in Tunisia is strongly related to the extreme poverty of governorates. The estimated coefficient of this variable is statistically significant and negatively related to the efficiency scores. For instance, an increase in the level of poverty reduced the efficiency education. However, the efficiency of basic and secondary education is positively influenced by the level of employment within governorates.Improving employability and increasing the chance of finding employment ameliorate the level of education efficiency in Tunisian governorates.

The non-discretioanryfactor per capita GDP (Y) introduced in the analysis of Tobit regressions is not statiscally significant in explaining the efficiency of education in Tunisia (P-Value > 0.05).

Therefore, with the Tobit results in Model 1 in Table 10, it is possible to correct the efficiency scores by accounting for the information of those exogenous factors. Table 11 provides those corrected efficiency scores (normalized by dividing by the maximum corrected score). In the first column, we present the original DEA scores estimated from an output-oriented DEA model with VRS assumption (Table 6, 2008). The score corrections for the two non-discretionary variables, extreme poverty and employment,are reported in the second and third column respectively. They are computed as the changes in scores by artificially considering that P and E varied to the sample average in each governorate. Finally, thefully corrected scores result from the addition of the previous three columnsm are presented in column (4).

By comparing the ranks in the last column of Table 11, after the corrections for the non-discretionary effects, with the ranking from the DEA analysis (column 2), we can observe some changes. Indeed, some countries that were before further away from the production possibility frontier are now deemed as less inefficient.

[6] See, for instance, Ruggiero (2004) and Afonso and Aubyn (2006).

Table 11
Corrected efficiency scores (for Table 6, 2008).

	Original DEA scores (1)	Poverty correction (2)	Employment correction (3)	Corrected scores (normalized) (4)=(1)+(2)+(3)	Rank
Ariana	0.980	0.0069	0.0089	0.972	10
Beja	0.990	−0.0011	−0.0007	0.965	13
Ben Arous	1.000	0.0057	0.0056	0.988	4
Bizerte	0.990	−0.0027	0.0083	0.972	11
Gabes	0.960	−0.0028	−0.0091	0.926	21
Gafsa	0.940	0.0003	−0.0137	0.905	24
Jendouba	0.990	0.0027	−0.0108	0.959	14
Kairouan	0.980	−0.0105	−0.0028	0.944	17
Kasserine	0.980	−0.0147	−0.0149	0.928	20
kebili	0.950	−0.0015	−0.0058	0.921	23
Le Kef	0.990	−0.0008	0.0018	0.968	12
Mahdia	1.000	0.0062	0.0011	0.984	7
Manouba	1.000	0.0017	−0.0009	0.977	8
Medenine	0.960	0.0035	−0.0024	0.939	18
Monastir	0.990	0.0093	0.0107	0.986	5
Nabeul	1.000	0.0084	0.0157	1.000	1
Sfax	1.000	0.0059	0.0071	0.989	2
Sidi Bouzi	0.970	−0.0151	0.0027	0.935	19
Siliana	0.980	−0.0041	−0.0033	0.950	16
Sousse	1.000	0.0075	0.0052	0.989	3
Tataouine	0.950	−0.0051	0.0010	0.924	22
Tozeur	0.990	−0.0001	−0.0118	0.955	15
Tunis	1.000	0.0069	0.0029	0.986	6
Zaghouan	1.000	−0.0065	0.0052	0.975	9

5. Conclusion

This research used the output maximization Data Envelopment Analysis approach with constant returns to scale (CCR model) and variable returns to scale (BCC model) to evaluate the efficiency of 24 Tunisian governorates in terms of 2nd cycle of basic education and secondary education in 1999, 2003, 2006 and 2008. Six input and output variables are selected to assess these governorates' efficiency. Variables describing schools' quality, financial resources and governorates' educational characteristics (number of teachers/100 students, number of classes/100 students, education spending per student and number of schools per million inhabitants) are used as inputs; while outputs include success rate in Baccalaureate exam and the rate of non-doubling in the 9th year.

The results of CCR model have an average of 86%, 97%, 92% and 93% in 1999, 2003, 2006 and 2008 respectively. The most recurring peers are the governorates of Sfax, Gafsa, Ben Arous and Nabeul in 1999, 2003, 2006 and 2008 respectively. The results of output-oriented VRS DEA have an average of 84%, 99%, 97% and 98% in 1999, 2003, 2006 and 2008 respectively. The most recurring peers are the governorates of Sfax, Kef, Ben Arous and Sousse in 1999, 2003, 2006 and 2008 respectively.

It is noted from the analysis that BCC model yields more efficient DMUs than CCR model. This result could be explained by the fact that the non-assumption on the convexity constraint enlarges the feasible region for CCR model and reduces efficient DMUs compared to BCC model (Charnes et al., 1994).

The arrangement of governorates in two groups by comparing their efficiency scores to the average efficiency of 24 governorates shows clearly a regional imbalance in the efficiency of 2nd cycle of basic education and secondary education in Tunisia. Most efficient governorates are belonging to North East and Centre East regions. The governorates whose efficiency scores are below the average output efficient score belong to North West and South regions. This disequilibrium between East regions and other regions of the country in terms of education efficiency can be explained by the disparity of the socioeconomic factors characterizing each region.

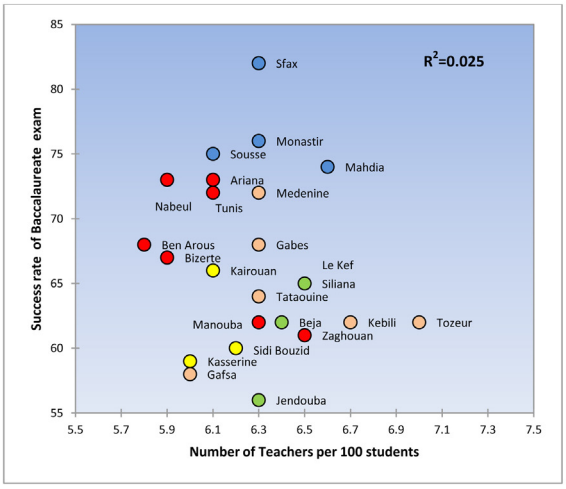
The results estimated with Mann-Whitney test demonstrate an absence of significant effect of school resources on the efficiency of governorates in terms of 2nd cycle and secondary education. The only factor that influences the efficiency level of education is the output variable "non-doubling in the 9th year". Improving student achievement in the 9th year and increasing the non-doubling rate of pupils in this year influence positively the efficiency of governorates in terms of 2nd cycle of basic education and secondary education.

In addition, we also explain data envelopment analysis output scores using so-called non-discretionary inputs using Tobit regressions. In this cae we find significant effects of employment and poverty in governorates on the efficiency level of basic and secondary education in Tunisia.

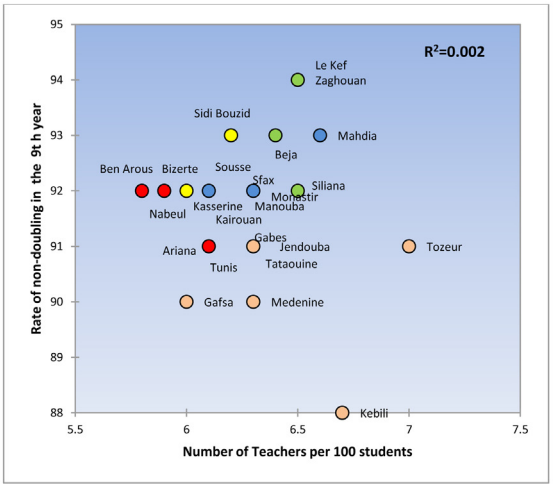
Improving the efficiency level of education in Tunisia necessitates a reduction of regional disparities between East region (North East and Centre East regions) and other regions of the country. East and West regions should be the economic centres each with its role and contribution to the national level with an equitable sharing of roles between capital, big cities and inland regions for establishing a climate that favours fairness and respect.

Appendix A. Scatter plots of input and output variables.

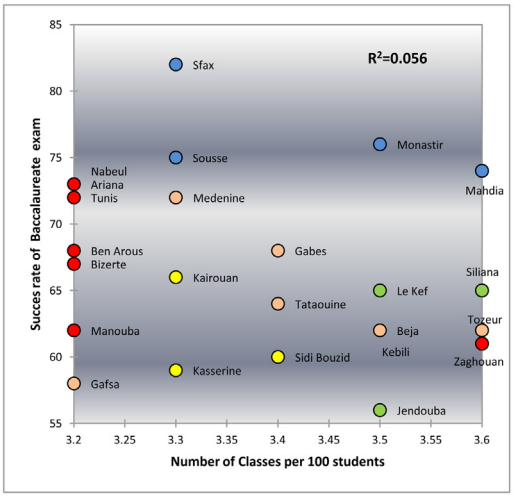
(a) Scatter plot of the number of teachers/100 students and the success Rate of baccalaureate exam



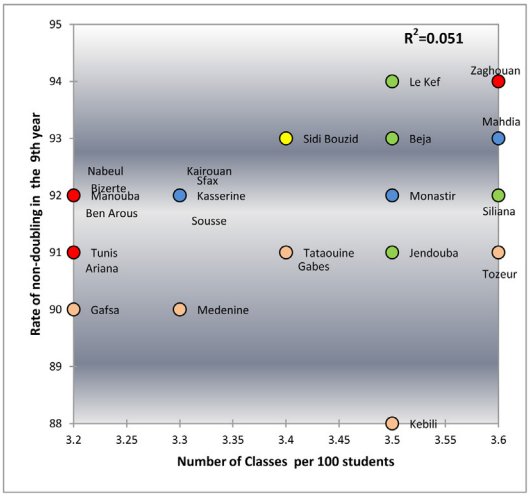
(b) Scatter plot of the number of teachers/100 students and the non-doubling in the 9th year



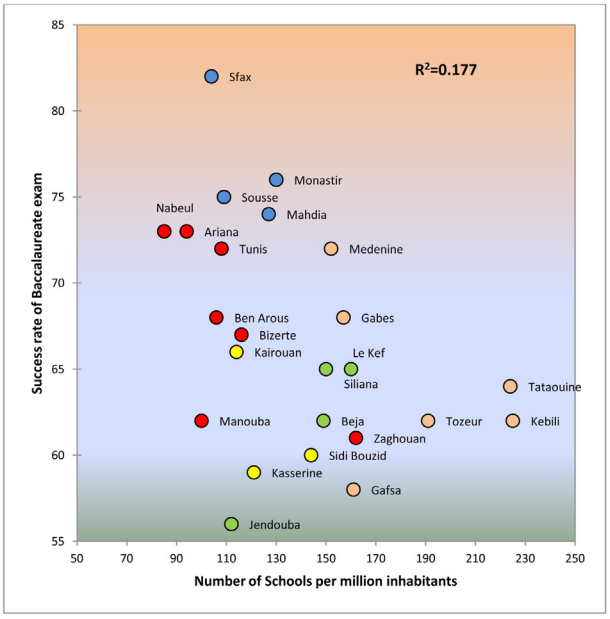
(c) Scatter plot of the number of classes per 100 students and the success rate of baccalaureate exam



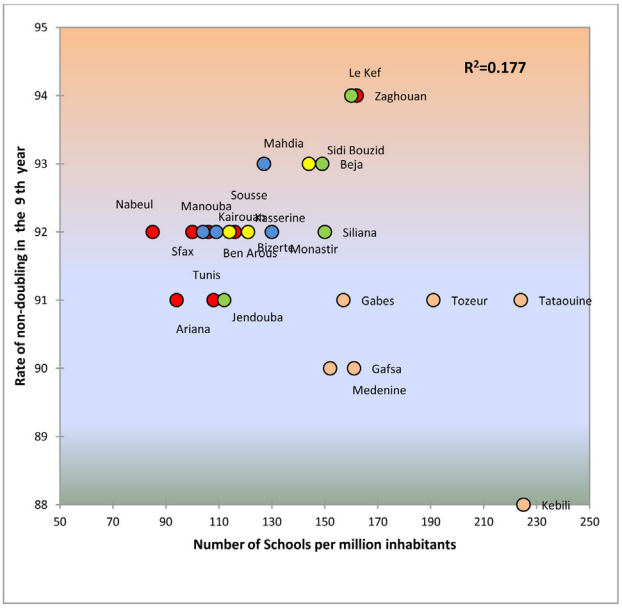
(d)Scatter plot of the number of classes per 100 students and the rate non-doubling rate in the 9 th year



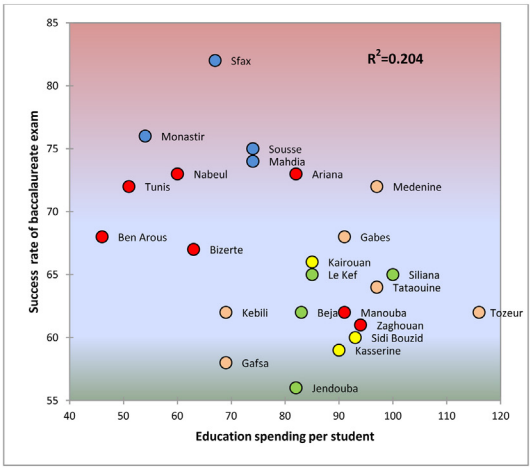
(e) Scatter plot of the number of schools per million inhabitants and the success rate of baccalaureate exam



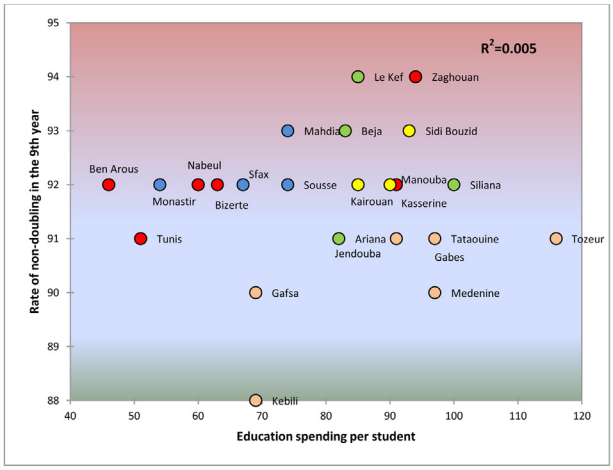
(f) Scatter plot of the number of schools per 100 students and the rate of non-doubling in the 9th year



(g) Scatter plot of education spending per student and the success rate of baccalaureate exam



(h) Scatter plot of education spending per student and the rate of non-doubling in the 9thyear



Circleswith Redcolour indicatethe governoratesofNorthEast Region

Circleswith Bluecolour indicatethe governoratesofCentre East Region

Circleswith Greencolour indicatethe governoratesofNorth West Region

Circleswith Yellowcolour indicatethe governorates of Centre West Region

Circleswith Pinkcolour indicatethe governoratesofSouth Region

Appendix B. Test of Pearson's correlation.

Correlation Matrix (Pearson) :		
Variables	Teachers	Bacc
Teachers	**1**	−0,160
Bacc	−0,160	**1**

P-values:		
Variables	Teacher	Bacc
Teacher	**0**	0,455
Bacc	0,455	**0**

Coefficients of determination (R^2):		
Variables	Teachers	Bacc
Teachers	**1**	0,026
Bacc	0,026	**1**

Correlation Matrix (Pearson) :		
Variables	Teacher	Non-doubling rate in the 9th
Teachers	**1**	−0,049
Non-doubling		**1**

P-values:		
Variables	Teacher	Non-doubling rate in the 9th
Teachers	**0**	0,821
Non-doubling		**0**

Coefficients of determination (R^2):		
Variables	Teachers	Non-doubling rate in the 9th
Teachers	**1**	0,002
Non-doubling rate in the 9th		**1**

Correlation Matrix (Pearson) :		
Variables	Bacc	Class
Bacc	**1**	−0,237
Class	−0,237	**1**

P-values :		
Variables	Bacc	Class
Bacc	**0**	0,266
Class	0,266	**0**

Coefficients of determination (R^2):		
Variables	Bacc	Class
Bacc	**1**	0,056
Class	0,056	**1**

Correlation Matrix (Pearson) :		
Variables	Spending	Non-doubling rate in the 9th
Spending	**1**	0,075
Non-doubling	0,075	**1**

P-values:		
Variables	Spending	Non-doubling rate in the 9th
Spending	**0**	0,727
Non-doubling	0,727	**0**

Coefficients of determination (R^2):		
Variables	Spending	Non-doubling rate in the 9th
Spending	**1**	0,006
Non-doubling rate in the 9th	0,006	**1**

Bold values are different from 0 to a level of significance alpha = 0.05.

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