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Assessing Productivity Performance of Basic and Secondary Education in Tunisia: A Malmquist Analysis

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Abstract

This study analyzes the productivity changes in basic and secondary education for 24 governorates in Tunisia over the period 2004-2008. In methodological term, the Malmquist index is employed, to estimate changes in total factor productivity (TFP) which can be decomposed into two main components namely, technological change and technical efficiency change. Four input variables (number of teacher per students, number of classes per students, number of schools per inhabitants, and expenditure in education per student) are used and two output variables measuring success rate of baccalaureate exam and rate of non-doubling in the 9th year. Results show that on average, changes in TFP growth during the period 2004-2008 has been more linked to the changes in technology. The managerial efficiency does not have an important effect on the variation of TFP change. Generally, productivity is associated with technological innovations.

Key Words: Basic and secondary education, productivity change, efficiency change, DEA, Malmquist index

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1. Introduction

It is important to evaluate the efficiency of an education system, but it is insufficient without evaluating productivity changes in this sector. Understanding the factors affecting productivity changes through time allows the detection of system inadequacies which can lead to improved productivity with an increase in the output produced and by reducing the amount of inputs used. This improvement of productivity translates into organizational effectiveness that can characterize each decision unit. Many organizational researchers and practitioners are interested in the measurement and analysis of productivity change in many sectors such as health, banking, and tourism.

In this paper, the productivity changes are evaluated in basic and secondary education for 24 governorates in Tunisia over the period 2004-2008. Malmquist index is employed to estimate changes in total factor productivity which can be decomposed into two main components namely, technological change (TECHCH) and technical efficiency change (EFFCH). Technological change implies shifts in the frontier or development of technology (innovation) and efficiency change implies catching up to the frontier. Four input variables (number of teacher per students, number of classes per students, number of schools per inhabitants, and expenditure in education per student) are used and two output variables measuring success rate of baccalaureate examination and rate of non-doubling in the 9^{th} year.

The paper is organized as follows; in section 2, the Tunisian basic and secondary education system is presented. Section 3 presents the literature review on some of the related existing literature on assessing productivity performance of education sector using Malmquist Productivity Index (MPI). In section 4, the productivity measurement introducing the Malmquist Productivity Index (MPI) is briefly explained. Section 5 presents the data used in this study and analyze the estimated results. Finally, section 6 provides the conclusion.

1.1 The Tunisian Basic and Secondary Education System

Education is an important sector for stimulating economic growth and promoting social development in each country. It consists of a fundamental right guaranteed without discrimination. The Tunisian education system was characterized by a significant qualitative change during the 21st century such that the enrollment rate of children aged from 6 to 16 years old reached 92 percent in both rural and urban areas recent years.[1]

Basic Education

Basic education consists of nine years of school education and it concerns children aged from 6 to 14 years old. It is divided in two complementary cycles. The first cycle is provided in primary schools for a period of six years with 3 degrees where each level lasts for 2 years. The second cycle is provided in colleges with duration of 3 years. The end of this cycle is marked by a diploma of basic education's study obtained at 9th year. Obtaining this diploma allows the transition of students from basic education to secondary education. The number of students enrolled in the 2nd cycle of basic education and teachers in 2005-2006 were 587064 and 34618 respectively.[2]

Secondary Education

On the other hand, secondary education is available to holders of diploma at the end of basic education's study and it lasts for four years. The first year is a core curriculum for all students intended to strengthen student learning at the preparatory cycle and helps them to choose the most appropriate orientation. At the successive three years, students can specialize in 7 branches (Language arts, Experimental Sciences, Economics, Mathematics, Technical Sciences, Data Processing and Sport). At the end of

[1] Ministry of Education and training « the development of education", national report, 2004-2008

[2] Ministry of Education and training

fourth year of secondary studies, students pass a national examination bachelor. Those who succeed this examination will get the baccalaureate diploma that allows them to begin training in public higher education. In 1995, 42.5 percent of baccalaureate takers were successful.

2. Literature Review

Education is one of the most important functions provided by the government in almost every country. Analysis of productivity change of this sector is essential to detect weaknesses that threaten the development of the education system in each governorate and choose the most appropriate options to ensure recovery of this sector.

The use of Malmquist Productivity Index (MPI) to measure change of productivity in education has been widely applied in several studies. The productive performance of individual New Zealand (NZ) secondary schools was analyzed by Mohammad Jaforullah in (2010) using MPI with panel data gathered on 333 schools for the period 1997 to 2001. The author used seven input variables (number of pupils per year 13, number of pupils per year 12, number of pupils per year 11, number of pupils in others years, teachers' salaries, administrative expenses and expenditure on learning resources), three output variables (the output of School Certificate (SC); the sum of all marks gained by its pupils in all papers they sat in, the output of Sixth Form Certificate (SFC); the number of year 12 students gaining this qualification, the output of University Bursary (UB) examination) and two environmental variables (isolation index variable (ISOLATN) and socio economic status indicator (SES) of the community). He concludes that generally schools have experienced deterioration in their total factor productivity at an annual rate about 1 percent due to technical regression. Some secondary schools were characterized by a TFP improvement or at least did not suffer any deterioration in their productive performance on average during 1997-2001, which is due to a positive change in both efficiency and technology.

Forsund and Kalhagen (1999), measure efficiency and productivity

change of 26 regional colleges in Norway for three years 1994, 1995 and 1996 using Data Envelopment Analysis (DEA) model and Malmquist Productivity Index. Three output variables are used including final examination distributed in short and long studies (which means studies stipulated from 6 months up to 2 years plus one year extension course and studies stipulated for 3 years or more) and research publications (papers in professional journals, papers in academic journal). The input variables are described by faculty staff, administrative staff, net operating expenses and building capital. Using Malmquist Productivity index (MPI), authors conclude that productivity change each year was mainly positive, most departments were characterized by positive productivity effect from frontier shift, but a greater variation results from catching up. The departments that are catching up with the best practice departments represent about 45 percent of the students.

The efficiency of higher education was also assessed with the DEA framework. In this field, Avkiran (1999) examines the relative efficiency of 36 Australian universities in 1995 using DEA model. Estimating three models (overall performance of universities, delivery of educational services and the success of universities in attracting fee paying students) under the assumption of VRS, the study concludes that university sector was performing well on technical and scale efficiency and a small number of universities were operating at increasing returns to scale.

Worthington and Lee (2001) evaluated productivity growth in 35 Australian Universities using non parametric frontier techniques over the period 1998-2003. They use as input variables , full-time equivalent academic and non-academic staff, non-labor expenditure, undergraduate and postgraduate student load while output variables are presented by, undergraduate, postgraduate & PhD completions , industry grants and publications. They also conclude that annual productivity growth averaged 3.3 percent across all universities, with a range between -1.8 percent and 13.0 percent, and was largely due to technological progress. The analysis of technical efficiency of these universities shows that pure technical efficiency

deteriorated by 0.1 percent while scale of efficiency improved by 0.1 percent. They also concluded that most productivity growth was related to improvements in research rather than teaching.

In addition, Afonso and St. Aubyn (2013) also used this framework for a cross section of OECD countries, to replace the macroeconomic production function by a production possibility frontier, total factor productivity being the composite effect of efficiency scores and possibility frontier changes. They assessed the time periods of 1970, 1980, 1990 and 2000 with one output – GDP per worker –and three inputs – human capital, public physical capital per worker and private physical capital per worker, and conclude that private capital is important for growth, although public and human capital also contribute positively.

3. Productivity Measurement

3.1 Analytical Framework

In this section literature corresponding to the non-parametric measures of efficiency and productivity change in a decision making unit (DMU) is briefly presented.

According to Farell (1957), economic efficiency is composed of two components: "allocative efficiency" (AE) and "Technical efficiency" (TE).These two measures form the overall efficiency (OE) relation as follows: OE=TE×AE.

Technical efficiency (TE) consists of the ability of a firm to transform multiple resources (inputs) into multiple outputs during a production process. This can appear in two forms either by producing the maximum output from a set of given inputs (output oriented), or, alternatively by the possibility of reducing the amount of inputs used to produce the same level of output (input-oriented). We consider a school or an institution of higher education technically efficient if it appears in its production frontier. The allocative

efficiency represents the capacity of a DMU to use the inputs in optimal proportions. A firm is considered efficient when it is located on the cost or revenue frontier.

The analysis of economic efficiency over time (cross –sectional context) takes a measure of productivity change and an examination of the origin of these changes. In this field, productivity is defined as "the ratio of an index of output to an index of input used during a production process".

The Measurement of productivity consists of evaluating change in the ratio of outputs over inputs used in a decision unit between a base period and the current period.

There are several index numbers used to measure productivity change e.g. the Laspeyres and Paasche indices represent the two most basic formulas used to calculate price indices; the former uses the base period data of quantities or prices as weights and the latter uses current period's as weights. Also the Tornqvist index which was developed in 1930s at the bank of Finland represents the changing-weight index for measuring productivity change. For comparing inputs over two time periods, this index employs on average the cost-share weights for two periods considered and it's often presented in a log–change form. Another index method that can be used to evaluate the productivity change is the Fisher Index that represents a geometric average of Laspeyres and Paasche indices. In productivity studies, this index is used less frequently than the Tornqvist index.

All the indices noted above are based on two assumptions that characterize the behavior of DMUs and technology: (1) DMUs are economically efficient; (2) technology is presented in the form of constant returns to scale.

In this study the Malmquist (1953) productivity index (MPI) is used, proposed by Caves, Christensen and Diewert (1982) in the productivity change measurement literature. It is defined in terms of distance functions

and to account for inefficiencies, production functions should be replaced by distance functions (OECD, 2001). It represents an indicator of productivity used to analyze the causes that generate productivity changes through panel data.

3.2 Malmquist Productivity Index (MPI)

The MPI measures the total factor productivity (TFP) over two time periods through ratios of distance functions which can be estimated using various methods (linear programming method, DEA).Fare et al. (1994) were the first to demonstrate that TFP indices could be decomposed into two components, efficiency change index and technical change index.

In many studies, productivity change was related to technical change but recently, efficiency change can also explain it. In our study, we use output-oriented Malmquist productivity index change provided by Fare et al. (1994) to estimate changes in total factor productivity in basic and secondary education of 24 governorates in Tunisia between 2004 and 2008.

The output-oriented Malmquist TFP change between two periods (t) and (t+1) is presented in this form:

$$m_0(y_1, x_1, y_{t+1}, x_{t+1}) = \left[\frac{d_0^t(y_{t+1}, x_{t+1})}{d_0^t(y_t, x_t)} \times \frac{d_0^{t+1}(y_{t+1}, x_{t+1})}{d_0^{t+1}(y_t, x_t)}\right]^{1/2} \quad (1)$$

where $d_0^t(y_{t+1}, x_{t+1})$and $d_0^{t+1}(y_t, x_t)$represent mixed-period distance functions from the period (t+1) observation and the period (t) technology and from period (t) observation relative to the period (t+1) technology respectively.

Output-oriented Malmquist TFP indicates improvement or growth in productivity from period (t) to period (t+1) when it is greater than one$(m_o > 1)$, a decline in productivity when it is lower than one $(m_o < 1)$

and finally equal to one means no change in productivity ($m_o = 1$).

Following Fare et al. (1994), Malmquist index can be decomposed into two components: one representing a measure of efficiency change and another measuring frontier change as follows:

$$m_0(y_1, x_1, y_{t+1}, x_{t+1}) = \frac{d_0^{t+1}(y_{t+1}, x_{t+1})}{d_0^t(y_t, x_t)} \times \left[\frac{d_0^t(y_{t+1}, x_{t+1})}{d_0^{t+1}(y_{t+1}, x_{t+1})} \times \frac{d_0^t(y_t, x_t)}{d_0^{t+1}(y_t, x_t)}\right]^{1/2} \quad (2)$$

The first component EFFECH=$\frac{d_0^{t+1}(y_{t+1}, x_{t+1})}{d_0^t(y_t, x_t)}$ measures efficiency change (change in technical efficiency). The second component TECHCH = $\left[\frac{d_0^t(y_{t+1}, x_{t+1})}{d_0^{t+1}(y_{t+1}, x_{t+1})} \times \frac{d_0^t(y_t, x_t)}{d_0^{t+1}(y_t, x_t)}\right]^{1/2}$ measures technology frontier (technological change).

The main characteristic of Malmquist index is its ability to decompose total factor productivity change (TFPCH) into, catching-up effect (efficiency change, EFFCH) and Frontier-shift effect (technical change, TECHCH). Efficiency change (EFFECH) can be further disaggregated into pure technical efficiency change (PECH) and scale efficiency change (SECH). The advantage of this index is that for panel data, it allows a description of multi-outputs and multi-inputs production technologies neither without prior behavioral assumption on the production technology nor input or output price data (Celli, Rao and Bettese, 1998).

The frontier shift (TECHCH) value greater than one indicates a positive shift or technical progress and less than one describes a situation characterized by a technical regression relative to the previous period or a negative shift. The catch up index takes a value greater than one for an efficiency improvement, zero for no efficiency variation and less than one for a decreasing efficiency.

Pure technical efficiency (PTE) is a measure of managerial performance to arrange the inputs in a production process. It is obtained by estimating efficiency frontier under the assumption of variable returns to scale. A PECH >1, means an improvement of the pure technical productivity which reflects that it is getting closer to the change scale reward production frontier and a decreasing score of pure technical efficiency (PECH<1) shows that all inefficiency is related directly to managerial underperformance in organizing the DMU's inputs.

Scale of efficiency (SE) represents the capacity of management to fix the optimum size of resources and the choice of scale of production in a firm that will attain the anticipated production level. Inefficiencies in this case can be related to inappropriate size of a firm (too large or too small). SECH>1, means that the production scale of the DMU is getting closer to the long term most appropriate production scale; while SECH<1 shows that the production scale characterizing the DMU does not attain the most appropriate production scale. We disaggregate below those effects:

$$TFPCH(t,t+1) = \frac{D_{t+1}^{VRS}(x_{t+1},y_{t+1})}{D_t^{VRS}(x_t,y_t)} \times \frac{D_{t+1}^{CRS}(x_{t+1},y_{t+1})/D_{t+1}^{VRS}(x_{t+1},y_{t+1})}{D_t^{CRS}(x_t,y_t)/D_t^{VRS}(x_t,y_t)} \quad (3)$$
$$\times \left(\frac{D_t^{CRS}(x_{t+1},y_{t+1})}{D_{t+1}^{CRS}(x_{t+1},y_{t+1})} \times \frac{D_t^{CRS}(x_t,y_t)}{D_{t+1}^{CRS}(x_t,y_t)}\right)^{1/2}$$

PECH — SECH — TECHCH

where $TFPCH = PECH + SECH + TECHCH$.

TFPCH can be improved either by adopting innovation (technological change, TECHCH) or by using technology and economic inputs efficiently in a decision making unit (EFFCH, technical efficiency change) or by adopting the two strategies together.

4. Description of Data and Empirical Results

4.1 Description of Data (Table 1)

This study analyzes productivity changes of basic and secondary education in 24 governorates of Tunisia through the period 2004-2008[3]. We use two output variables:

-Success rate of baccalaureate examination. This variable represents the grade obtained at the end of high school. Obtaining this diploma is essential to provide access to higher public education. This rate has reduced by 1.6 percent from 2004 to 2008 and ranged from 68.1 percent to 67 percent during this period.

-As a second output measure, we used the rate of non-doubling in the 9th year which represents a final examination of 2nd cycle of basic education. This rate was characterized by a slight reduction of 0.4 percent during 2004-2008, varying from 91.2 percent in 2004 to 90.8 percent in 2008.

Four input variables are employed. The first variable describes the number of teachers per 100 students. This ratio is used to measure the number of teachers in terms of the level of human resource input in each governorate. It can provide information on the quality and the conditions of teaching in each governorate. Between 2004 and 2008, the number of teachers per 100 students increased from 5.5 to 7.1.

A second input variable called “number of classes per 100 students” is selected. This indicator measures the amount of human resources invested in terms of students compared to the number of classes in all schools for each governorate. Between 2004 and 2008, this variable has increased by 16.1 percent.

The third input variable used in our analysis describes the number of

[3] All data are sourced from Ministry of Education, Tunisia

schools per inhabitants in each governorate. During2004-2008, this variable varied from 119.3 schools in 2004 to 128.3 in 2008.

Another input variable that measures education spending per student for each governorate is introduced. These expenditures where devoted to equipping schools (extension of schools and classrooms). This variable decreased by 27 percent during 2004-2008.

Table 1
Descriptive Statistics of Data

		Mean	Standard Deviation	Max	Min
Number of teachers per students	2004	5.5	0.2	5.9	5.2
	2006	6.3	0.28	7	5.8
	2008	7.3	0.4	8.4	6.6
Number of classes per students	2004	3.1	0.1	3.3	3
	2006	3.3	0.15	3.6	3.1
	2008	3.7	0.19	4.1	3.4
Number of inhabitants	2004	133.0	35.8	216	84.8
	2006	138.4	37.9	226.8	82.6
	2008	143.5	40.5	236.8	87.2
Expenditure per student	2004	80.8	17.8	111.1	52
	2006	77.7	23.2	129.5	33.3
	2008	62.9	23.7	149.7	24.6
Success rate of Baccalaureate Examination	2004	67.1	6.4	84	54.7
	2006	61.4	8.8	80	46.1
	2008	65.5	8.25	81.3	52.6
Rate of non-doubling in the 9^{th} year	2004	91,4	1.4	93.8	88.1
	2006	90.5	2.1	93.9	84.7
	2008	90.8	1.6	93.7	87.3

5. Empirical Results

The calculation of Malmquist index for evaluating the productivity changes in 24 governorates of Tunisia in terms of basic and secondary education between 2004 and 2008 allows us to conclude that 4 governorates: Tunis, Ben Arous, Sousse and Nabeul have been marked by an increase in the productivity (TFPCH >1). The highest productivity growth belongs to the governorate of Ben Arous (TFPCH=1.301).Through analyzing the elements

of this index we noticed that efficiency change has remained unchanged; therefore productivity changes (Malmquist index) are led by technological change. This means that the governorate of Ben Arous was characterized by an improvement of technology and an implantation of new investments in terms of basic and secondary education between 2004 and 2008 (see Table 2). This can be represented in the form of new equipment and materials used in schools.

The governorate of Tunis noticed an improvement of 2.6 percent in the

Table 2
Malmquist Index (2004-2008)

Governorate	Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change	Rank
Tunis	1.000	1.026	1.000	1.000	1.026	4
Ariana	0.989	0.947	0.989	1.000	0.937	6
Manouba	0.995	0.906	1.001	0.994	0.901	9
Ben Arous	1.000	1.301	1.000	1.000	1.301	1
Zaghouan	0.989	0.811	1.000	0.989	0.802	17
Bizerte	0.995	0.826	0.998	0.997	0.822	15
Beja	1.018	0.816	0.996	1.022	0.831	14
Jendouba	0.977	0.842	1.003	0.974	0.822	15
Siliana	0.958	0.812	0.991	0.967	0.778	21
Kef	1.003	0.818	0.987	1.016	0.821	16
Kasserine	0.978	0.815	0.991	0.988	0.798	18
Sidi Bouzid	0.941	0.816	0.979	0.961	0.768	23
Gafsa	0.924	0.901	0.951	0.971	0.833	13
Tozeur	0.944	0.831	0.998	0.946	0.785	20
Kebili	0.924	0.910	0.997	0.927	0.840	12
Tataouine	0.969	0.817	0.976	0.993	0.792	19
Medenine	0.953	0.935	0.960	0.992	0.891	10
Gabes	0.936	0.827	0.987	0.949	0.774	22
Sfax	1.000	0.954	1.000	1.000	0.954	5
Mahida	0.929	0.954	1.029	0.903	0.886	11
Kairouan	0.971	0.944	0.998	0.974	0.916	7
Monastir	0.972	0.934	0.991	0.981	0.908	8
Sousse	1.039	1.036	1.030	1.009	1.076	2
Nabeul	1.000	1.045	1.000	1.000	1.045	3
Mean	0.975	0.903	0.994	0.981	0.881	

productivity between 2004 and 2008 resulting from an increase in the technological change (1.026) while the efficiency change (1.000) has remained stable during the study period.

On the other hand, the worst performance was related to the governorate of Sidi Bouzid such as the total factor of productivity change was equal to 0.768 between 2004 and 2008.This decrease in the productivity comes from a reduction of 5.9 percent on the efficiency and about 18.4 percent on technological change. This could be the result of inefficient allocation policy of school resources and the use of educational equipment and materials less developed during the period 2004-2008.

On average, the productivity of the country decreased about 11.9 percent between 2004 and 2008. This decrease was caused by a reduction of 2.5 percent in the efficiency change and about 9.7 percent in the technological change. The reduction of efficiency change is the result of a decrease by 0.6 percent in the pure technical efficiency and about 1.9 percent in scale efficiency. So the major source of inefficiencies of 24 governorates in terms of basic and secondary education during this period is technological inefficiencies.

Through the calculation of Malmquist index over the period 2004-2006 (Table 3), there are 3 governorates characterized by an improved productivity (total factor productivity change >1) (Tunis, Ben Arous and Medenine). Similar to the result of Table 2, the governorate of Ben Arous, marked by a TFP growth of 18 percent, appears to be the most productive compared to other governorates due to high innovation (technological change improved by 18 percent). While the efficiency change remains stable during 2004-2006.

On the other hand the worst performance was associated to the governorate of Tozeur with a TFP deterioration of 16.9 percent. Thus results in a reduction of 5.7 percent of the technological innovation and a deterioration of 11.9 percent of efficiency.

As indicated in Table 3, on average, the TFP was less than one between 2004 and 2006. The productivity deteriorated by8.2 percent due to a reduction of 4.7 percent of technological innovation. For efficiency performance, a deterioration of 3.7 percent is observed, that was due to scale inefficiency and thus, failed to reach the efficient frontier. It implies that managerial efficiency performance of these governorates needs more improvement and efficient application of school's resource allocation must be applied.

Table 3
Malmquist Index (2004-2006)

Governorate	Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change	Rank
Tunis	1.000	1.028	1.000	1.000	1.028	3
Ariana	0.972	0.941	0.981	0.990	0.914	11
Manouba	0.976	0.964	0.996	0.980	0.941	6
Ben Arous	1.000	1.180	1.000	1.000	1.180	1
Zaghouan	0.959	0.931	0.978	0.978	0.893	16
Bizerte	0.994	0.928	1.000	1.000	0.923	8
Beja	0.989	0.934	0.995	0.995	0.924	7
Jendouba	0.922	0.929	0.945	0.945	0.856	21
Siliana	0.928	0.923	0.943	0.943	0.856	21
Kef	0.965	0.928	0.965	0.965	0.895	13
Kasserine	0.956	0.929	0.970	0.970	0.888	17
Sidi Bouzid	0.979	0.934	0.965	0.965	0.915	10
Gafsa	0.930	0.934	0.974	0.974	0.869	20
Tozeur	0.881	0.943	0.945	0.945	0.831	23
Kebili	0.885	1.039	0.926	0.926	0.920	9
Tataouine	0.947	0.929	0.967	0.967	0.880	19
Medenine	1.027	1.061	1.027	1.027	1.090	2
Gabes	0.969	0.923	0.971	0.971	0.894	14
Sfax	1.000	0.893	1.000	1.000	0.893	15
Mahida	0.986	0.911	1.028	0.959	0.898	12
Kairouan	0.961	0.923	0.981	0.979	0.887	17
Monastir	0.881	0.944	0.969	0.908	0.833	22
Sousse	1.028	0.921	1.022	1.006	0.947	4
Nabeul	1.000	0.944	1.000	1.000	0.944	5
Mean	0.963	0.953	0.988	0.974	0.918	

From Table 4 we note that there are only two governorates (Ben Arous and Nabeul) characterized by a positive productive performance (TFP>1). Governorate of Ben Arous with a remarkable TFP growth of 13.8 percent appears to be the most productive during the period 2006-2008 due its technological development (same result as Table 2 and 3).While the efficiency performance remains unchangeable.

The lowest productivity was linked to the governorate of Sidi Bouzid

Table 4
Malmquist index (2006-2008)

Governorate	Efficiency Change	Technological Change	Pure Technical Efficiency Change	Scale Efficiency Change	Total Factor Productivity Change	Rank
Tunis	1.000	0.975	1.000	1.000	0.975	6
Ariana	1.018	0.983	1.008	1.010	1.000	3
Manouba	1.019	0.919	1.005	1.014	0.936	9
Ben Arous	1.000	1.138	1.000	1.000	1.138	1
Zaghouan	1.031	0.868	1.019	1.012	0.895	15
Bizerte	1.000	0.884	1.003	0.997	0.884	18
Beja	1.030	0.883	1.002	1.027	0.909	12
Jendouba	1.059	0.879	1.027	1.031	0.931	10
Siliana	1.033	0873	1.007	1.025	0.901	13
Kef	1.039	0.877	0.987	1.053	0.912	11
Kasserine	1.023	0.872	1.005	1.018	0.892	17
Sidi Bouzid	0.961	0.875	0.965	0.997	0.841	23
Gafsa	0.994	0.873	0.997	0.997	0.868	21
Tozeur	1.072	0.895	1.070	1.001	0.959	8
Kebili	1.043	0.892	1.042	1.001	0.931	10
Tataouine	1.023	0.879	0.996	1.027	0.900	14
Medenine	0.928	0.946	0.960	0.966	0.877	19
Gabes	0.966	0.894	0.989	0.977	0.863	22
Sfax	1.000	0.996	1.000	1.000	0.996	4
Mahida	0.942	0.926	1.001	0.942	0.872	20
Kairouan	1.011	0.885	1.017	0.994	0.894	16
Monastir	1.043	0.934	1.015	1.028	0.974	7
Sousse	1.010	0.982	1.008	1.002	0.992	5
Nabeul	1.000	1.065	1.000	1.000	1.065	2
Mean	1.010	0.922	1.005	1.005	0.931	

(TFP=0.841) with a reduction of 3.9 percent in the efficiency and a deterioration of 12.5 percent in the technology used in basic and secondary education in this governorate over the period 2006-2008.

On average, we note a loss of productivity of 6.9 percent during the period 2006-2008. This loss solely due to the deterioration of technology is about 7.8 percent while the efficiency has been improved by 1 percent. It implies that the major source of inefficiencies is related to technological inefficiencies while the managerial efficiency performance of all governorates does not need further improvement to attain efficiency. During the period 2006-2008, all governorates have been able to well manage school resources (SECH and PECH are greater than one).

From Table 5, we noticed that the efficiency frontier in 2004 was composed of 8 governorates (Tunis, Ariana, Ben Arous, Zaghouan, Kef, Medenine, Sfax and Nabeul). Compared to 2004, the efficiency frontier in 2006 was marked by the disappearance of two governorates (Ariana and Zaghouan) and the appearance of the governorate of Sidi Bouzid. The improvement of efficiency for this governorate between 2004 and 2006 was mainly due to an improvement of pure technical efficiency of 1.5 percent but it is insufficient for this governorate which remains characterized by a low productivity between 2004 and 2006 primarily due to technological inefficiencies (see Table 3).

The efficiency frontier in 2008 was composed of 8 governorates (Tunis, Manouba, Ben Arous, Zaghouan, Sfax, Mahdia, Sousse and Nabeul). Compared to 2004, we notice the appearance of governorates of Manouba, Mahdia and Sousse and the disappearance of governorates of Ariana, Kef and Medenine on the efficiency frontier. The increase in efficiency for the governorates of Manouba, Mahdia and Sousse was mainly due to an improvement of pure technical efficiency of 0.1 percent, 2.9 percent and 3 percent respectively (see table 2). The two governorates of Manouba and Mahdia were characterized by deterioration of productivity during 2004-

2008, primarily due to a reduction of technological change of about 9.4 and 4.6 percent respectively. The governorate of Sousse experienced an improvement of productivity (TFP>1), caused essentially by an improved technology (TECHCH=1,036).

Table 5
VRS Efficiency Scores by Governorate (2004, 2006 And 2008)

Governorate	2004	2006	2008
Tunis	1.000	1.000	1.000
Ariana	1.000	0.981	0.989
Manouba	0.999	0.995	1.000
Ben Arous	1.000	1.000	1.000
Zaghouan	1.000	0.981	1.000
Bizerte	0.998	0.992	0.996
Beja	0.991	0.985	0.987
Jendouba	0.983	0.960	0.986
Siliana	0.986	0.970	0.977
Kef	1.000	1.000	0.987
Kasserine	0.989	0.975	0.980
Sidi Bouzid	0.985	1.000	0.965
Gafsa	0.988	0.943	0.940
Tozeur	0.989	0.922	0.949
Kebili	0.952	0.910	0.948
Tataouine	0.972	0.952	0.960
Medenine	1.000	1.000	0.955
Gabes	0.968	0.966	1.000
Sfax	1.000	1.000	1.000
Mahida	0.972	0.999	0.983
Kairouan	0.985	0.967	0.986
Monastir	0.994	0.972	1.000
Sousse	0.971	0.992	1.000
Nabeul	1.000	1.000	1.000
Mean	0.988	0.978	0.982

By comparing the composition of the efficient frontier between 2006 and 2008, we notice the appearance of 4 new efficient governorates (Manouba, Zaghouan, Mahdia and Sousse) and the disappearance of 3 governorates (Kef, Sidi Bouzid and Medenine). For the 3 inefficient governorates, we conclude that the pure technical efficiency was reduced from 1.3 percent, 3.5 percent and 4 percent respectively (Table 4). The deterioration of efficiency was mainly due to a reduction of pure technical efficiency because

considering the governorate of Kef, the efficiency change improved about 3.9 percent while the governorate still remains inefficient.

Table 6 and Figure 1 show, technical efficiency change, technological change and total factor productivity of all governorates from 2004-2008. It is observed that on average TFPCH, EFFCH and TECHCH are lower than one. From 2007, only EFFCH was characterized by a slight increase to reach 1.01 in 2008.

From figure 1, we notice that TFPCH and TECHCH are represented under the same shape. In 2007 there is a crossover of two curves. From this date, TFPCH becomes greater than TECHCH. It spent from 0.954 to attain 0.969 in 2008 which is mainly due to an increase in managerial efficiency (passed from 1 in 2007 to 1.01 in 2008). Between 2005 and 2006, we note an increase of TFPCH and TECHCH while EFFCH was slightly reduced by 0.1 percent. This indicates that the increase in TFP growth was due to technological progress.

Table 6
Malmquist Index Summary of Annual Means
of Governorates (2004-2008)

	EFFCH	TECHCH	TFPCH
2005	0.983	0.965	0.949
2006	0.982	0.977	0.960
2007	1.000	0.954	0.954
2008	1.010	0.959	0.969
Mean	0.993	0.963	0.958

During the period 2006-2007, it is observed that there was a decline in TFPCH of 0.6 percent due to a deterioration of technology which ranged from 0.977 to 0.954.While efficiency increased to reach the level 1.0 in 2007.

On average, the increase or the decrease of TFP growth during the period 2004-2008 is linked to changes in technology. The managerial efficiency does not have an important effect on the variation of TFP change. This leads us to conclude that productivity is generally associated with technological

innovations.

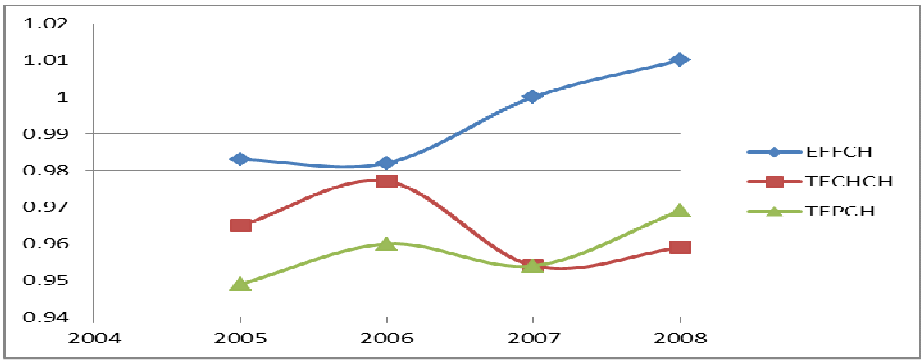

Figure 1: Malmquist Index Summary of Annual Means of Governorates

Table 7 summarizes the input-output slacks of 24 governorates in Tunisia in 2008. The calculation of slacks is needed to prompt DMU to reach the efficiency frontier. Input-output slacks exist only for governorates identified as inefficient. It's important to identify enhancement strategies for these governorates that are marked inefficient either by reducing the amount of input required (input slacks) or by increasing the amount of output (output slacks).

We notice from Table 7 that all efficient governorates in 2008 have neither input nor output slacks (Tunis, Manouba, Ben Arous, Zaghouan, Sfax, Mahdia, Sousse and Nabeul). They are efficient in achieving productivity change. The rest of governorates are considered inefficient. The governorate of Sidi Bouzid is required to reduce its number of teachers per 100 students by approximately 0.150, number of schools per inhabitant by 7 schools and education spending per student by 9 MD. However, this reduction of input is considered insufficient for the governorate to reach the efficiency frontier. It should also increase its success rate of baccalaureate examination by 8 percent.

The governorate of Tozeur needs to reduce its number of teachers per 100 students by 0.7, its number of schools per inhabitant by 57 schools and finally its education spending per student by 78 MD to become efficient.

Table 7
Summary of Input and Output Slacks (2008)

	Inputs slacks			Outputs slacks		
	Teachers per 100 students	Classes per 100 students	Number of schools per inhabitants	Expenditure of education per student	Success rate of Baccalaureate examination	Rate of non-repetition in the 9th year
Tunis	-	-	-	-	-	-
Ariana	0.125	-	-	9.892	0.580	-
Manouba	-	-	-	-	-	-
Ben Arous	-	-	-	-	-	-
Zaghouan	-	-	-	-	-	-
Bizerte	-	-	5.200	16.800	7.811	-
Beja	0.250	-	13.800	5.000	7.786	-
Jendouba	0.592	0.196	-	18.793	19.450	-
Siliana	-	0.010	7.542	17.638	-	-
Kef	0.250	-	26.800	5.800	8.596	-
Kasserine	0.025	-	0.050	18.350	14.756	
Sidi Bouzid	0.150	-	7.100	9.400	7.954	-
Gafsa	0.078	0.030	42.533	-	16.169	-
Tozeur	0.698	-	57.527	78.840	-	-
Kebili	1.000	0.186	107.797	-	13.810	-
Tatouine	0.350	-	94.500	6.500	1.573	-
Medenine	0.422	-	35.115	2.385	-	-
Gabes	0.064	-	27.792	3.347	-	-
Sfax	-	-	-	-	-	-
Mahdia	-	-	-	-	-	-
Kairouan	0.234	0.062	4.111	-	8.347	-
Monsatir	-	0.122	21.850	9.472	-	-
Sousse	-	-	-	-	-	-
Nabeul	-	-	-	-	-	-
Mean	0.177	0.025	18.822	8.426	4.451	-

The highest share of schools per inhabitant to be reduced exists in the governorate of Kebili (107 schools) and the lowest share of this input is in the governorate of Kasserine (0.05 schools).

Regarding the output slacks, they reflect the number of governorates with deficiencies only in the success rate of baccalaureate examination. Governorate of Ariana pegged at 0.58 percent, Bizerte with 7.8 percent, Beja

with 7.7 percent, Jendouba with 19.4 percent, Kef with 8.8 percent, Kasserine with 14.7 percent, Sidi Bouzid with 8 percent, Gafsa with 16 percent, Kebili with 13.8 percent, Tataouine with 1.5 percent and Kairouan with 8.3 percent.

On average, the most important reductions to be realized in 2008 for reaching the efficiency frontier are the number of schools per inhabitants (18 schools) and expenditure of education per student (8 MD).

In Table 8, we present the peers indicating benchmarking performance for each governorate. We notice that there are 8 governorates (Tunis, Manouba, Ben Arous, Zaghouan, Sfax, Mahdia, Sousse and Nabeul) considered as efficient since they represent the peers of themselves.

Table 8
Summary of Peers (2008)

Governorates	Peers
Tunis	Tunis
Ariana	NabeulTunis
Manouba	Manouba
Ben Arous	Ben Arous
Zaghouan	Zaghouan
Bizerte	Sousse
Beja	SousseZaghouan
Jendouba	ZaghouanSousse
Siliana	MahdiaSousseZaghouan
Kef	SousseZaghouan
Kasserine	ZaghouanSousse
Sidi Bouzid	SousseZaghouan
Gafsa	ZaghouanSousse
Tozeur	SousseZaghouanMahdia
Kebili	ZaghouanSousse
Tatouine	SousseZaghouan
Medenine	SousseZaghouanMahdia
Gabes	ZaghouanSousseMahdia
Sfax	Sfax
Mahdia	Mahdia
Kairouan	ZaghouanSousse
Monsatir	SousseMahdiaSfax
Sousse	Sousse
Nabeul	Nabeul

Using an output-oriented model, this means that these governorates did not need to benchmark performance of other governorates and they are not obliged to improve their output (success rate of baccalaureate examination and rate of non-doubling in the 9th year). However, there are 16 governorates (Ariana, Bizerte, Beja, Jendouba, Siliana, Kef, Kasserine, Sidi Bouzid, Gafsa, Tozeur, Kebili, Tataouine, Medenine, Gabes, Kairouan and Monastir) which are considered inefficient. These governorates are characterized by an input resource excess and a deficit in their output (as it is marked in table 6) and therefore need to benchmark the efficient governorates to improve their performance.

6. Conclusion

In this paper, we employ output-oriented Malmquist index to evaluate the productivity change of 24 Tunisian governorates in terms of basic and secondary education during the period 2004-2008. The input measures provide information on the amount of human resources invested in terms of students compared to the number of teachers and classes (number of teachers per 100 students and number of classes per 100 students). Another input variable describes the number of schools per inhabitants in each governorate. To measure the basic and secondary education costs, we introduced another variable describing education spending per student in each governorate. As output measures, we use the success rate of baccalaureate examination and the rate of non-doubling in the 9th year.

The decomposition of Malmquist Productivity Index (MPI) into technical efficiency change (EFFCH) and technological change (TECHCH) between 2004 and 2008 allows us to conclude that productivity change is largely related to technological innovations used to assure basic and secondary education to pupils (information technology and communication, experiments assisted with computer). This means that schools must face new challenges to satisfy the needs of current and future generations based on creation and technological innovation.

The managerial efficiency does not have an important effect on the TFP growth. During 2004-2008, the two governorates of Beja and Kef were characterized by an improvement of efficiency change about 1.8 and 0.3 percent respectively but productivity was reduced by 16.9 and 17.9 percent respectively due to technological inefficiencies.

On average, the productivity change has declined to 11.9 percent during 2004-2008 due to a reduction of efficiency change and technological change about 2.5 and 9.7 percent respectively. Reducing the period of analysis, we note that productivity increases but TFP still remains below unity. During 2004-2006 and 2006-2008, the productivity change increased about 4.2 percent and 5.6 percent respectively compared to the productivity analyzed during 2004-2008. This means that on average, the 24 Tunisian governorates haven't reached the productive performance level in terms of basic and secondary education. This necessitates introducing a culture of technological innovation in schools and an implementation of creativity demarche which is an important component of innovation.

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