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Efficiency Assessment of Secondary Schools in Mauritius: A DEA Approach

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ABSTRACT

In the context of the quantitative approach to the evaluation of educational units there is an emerging interest in discerning the factors that affect the performance of a school. The data envelopment analysis (DEA) methodology provides an effective agenda for evaluating the efficiency of educational units, such as the secondary schools, in the presence of multiple inputs and outputs. In this paper we evaluate the performance of Mauritian colleges through DEA. The data deal with overall % passes at school certificate and higher school certificate in all secondary colleges for the year 2016. The 141 colleges are bunched on the foundation of factors such as school facilities and school population. The analysis results indicate that efficiency of colleges ranged between 0 and 1 with an average of 0.872(CRS) and 0.909(VRS) using Tobit model. The second stage analysis found that the location, zone, types of colleges, teacher-student ratio, student-class ratio, college status and canteen have significant effect on school's performance.

Keywords: data envelopment analysis, colleges, efficiency

INTRODUCTION

This study aims to fill the gap by investigating the causal nexus between the inputs and performances in the different types of secondary schools and tries to further establish an efficiency score using the DEA approach. Therefore, the disparity between low performing schools and high achievers may be viewed from an efficiency scale instead of the traditional performance-based comparison. Some schools may have fewer inputs in terms of students, academic staffs and physical facilities but still they may have high efficiencies. This may help with a more humane decision-making process as far as the closing of private schools and allocation of grants are concerned. Mauritius depends very much on its grey matter for its economic prosperity as it has no natural resources. Therefore, a question about what drives education efficiency is crucial and the application of Data envelopment analysis (DEA) is a possible solution.

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Table 1. Nine year schooling objectives

Equip all students with knowledge, foundational skills and attitudes leading to an empowered 2030 citizenry.
Inculcate in all students a sense of moral responsibility, a set of values and a strong identity for the country.
Promote the holistic development of all students.
Provide equitable Learning for All opportunities to attain high levels of achievement.
Achieve a smooth transition to and completion of secondary education.
Give greater recognition to the value of Technical and Vocational Education and Training (TVET) in building human capital and for sustainable development.

LITERATURE REVIEW

What is Efficiency?

Efficiency is the achievement of an objective, utilizing a minimum amount of resources (Koontz & Weihrich, 2012). It is fundamentally a comparison between inputs used and attained outputs. In education, a performance measurement in terms of efficiency is defined as follows:

$$\text{Efficiency} = \frac{\text{Total Weighted Output}}{\text{Total Weighted Input}} \quad (1)$$

Efficiency of Schools (DEA)

DEA offers lucid advantages over other methods as a basis of information in shaping the efficiency of establishments that produce multiple outputs (Banker *et al.*, 1984). The methodology measures the relative efficiency without prior assumption of input-output weights. Another approach is the stochastic frontier analysis (SFA) which is a regression-based approach where it is possible to incorporate a larger number of inputs and to control for stochastic influences. Much work has been done under the banner of efficiency in the field of health and education (Grigoli, 2012; Gupta & Verhoeven, 2001; St. Aubyn *et al.*, 2009).

Most of the studies use the DEA to evaluate individual school performance and total system performance. However, some studies went further and try to relate efficiency to some school and local characteristics using a second stage analysis (Bradley 2001). In practice, analyzing the efficiency of DMUs (decision-making units) consists of a set of linear programming problems. We can assume constant returns to scale (CRS), which means that the DMUs are able to linearly scale the inputs and outputs without increasing or decreasing efficiency, implying that there is no significant relationship between DMUs' scale and efficiency. In other words, schools do not differ in transforming their inputs to outputs. Under variable returns to scale (VRS), an increase in inputs is expected to result in a disproportionate increase in the outputs, for instance, due to decreasing marginal returns (Cunha & Rocha, 2012). For instance, one study uses the two-stage DEA to evaluate technical efficiency and its determinants in education based on an output-oriented model with the assumption of VRS (Wolszczak-Derlacz, 2014). Some other studies utilize such approaches (Huguenin, 2015; Meunier, 2008). Wolszczak-Derlacz & Parteka (2011) employs the CRS model while others prefer both CRS and VRS, output oriented, second stage analysis with the use of Tobit regression (Agasisti & Pohl, 2012; St. Aubyn *et al.*, 2009).

DEA and Educational Findings

Soteriou *et al.* (1998) uses the methodology of DEA to measure the efficiency of secondary schools in Cyprus. Besides, the study provides commendations for upgrading inefficient schools and discusses managerial implications. The practical findings indicate that environmental effects show no efficiency differences between schools working in rural areas compared to those operating in urban areas.

Aristovnik and Obadić (2014) use the (DEA) technique to a wide range of EU and OECD countries, including Slovenia and Croatia, to evaluate the technical efficiency of secondary education. The results show that technical efficiency in secondary education fluctuates significantly across most of the countries. Therefore, it suggests that justifying public secondary education spending is strongly recommended and proposes to redirecting of some undue resources to the tertiary education sector.

Wolszczak-Derlacz (2014) uses DEA to assess the relative efficiency in higher education. It computes efficiency scores are using different input-output sets and variations in total factor productivity are evaluated

by the means of the Malmquist index and it is decomposed into pure efficiency changes and frontier shifts. The external factors affecting the degree of HEI inefficiency are size and department composition, location. The funding structure is investigated by means of two-stage DEA analysis (Simar & Wilson, 2007).

The efficiency of the school's teaching is affected directly by the environmental factor characterized by certain characteristics of students (Chodakowska, 2015). Therefore, this study considers the value-added students' knowledge instead of the absolute exam results changes evaluation of the schools' efficiency. The article considers the local and environmental context. On the basis of Bialystok's schools, the author shows that the implementation of DEA is beneficial and offers extra knowledge about the efficiency of management in educational institutions.

Xu and Liu (2017) provide a new tactic for assessing the input-output efficiency of education and technology. The DEA method analyzes the efficiency sharing activities in education and technology sector, and then categorizes input variables and output variables. Using a panel data, they find that the countries with significant progress in educational efficiency and technological efficiency are mostly focused in East Asia (Japan, Korea, Taiwan) and some other developing countries. Besides, the result indicates that the efficiency of science and technology has an effect on the balanced development of the country. They recommend the selection of the suitable education and technological policies for resource allocation and process evaluation.

EMPIRICAL LITERATURE REVIEW

A facility is referred to as a building, a space, a piece of equipment or machine that is provided at a place for people to use (Rundell, 2007). In a school building, space is required for academic and extra curricula activities to function properly. There are three basic spaces namely instructional spaces, recreational spaces and facilities. These spaces affect the users physically, psychologically and socially (Barrett & Zhang, 2009). Toilets, cafeteria, water, corridors and so on are commonly referred as space for convenience (Odufowokan, 2011). Suitable and quality school facilities are basic constituents for quality education and goal achievement (Khan & Iqbal, 2012). However, poor space for convenience facilities may negatively disturb teaching and learning process and hence adversely affect the students' learning outcomes (Ajayi & Yusuf, 2010). Geographical location denotes to the place where a school is situated whereas location is a particular place in relation to other areas (Jovinius, 2015). Therefore, the location of school is either urban or rural in our local context. In developing countries, the school location is associated with lower academic performance mainly in rural schools (Webster & Fisher, 2000). Public or state schools are managed by the government. Private schools are managed by a non-government organization, such as a church, a trade union or a private institution. Government-dependent private schools are managed autonomously but collect more than 50% of their core funding from the government whereas independent ones get less. Colleges receiving grants by the government are accountable for academic and financial results. Private schools have more autonomy, own budgets, class and school sizes, staffing levels, curriculum choices, and flexibility[1]. The permits of private schools are regularly reviewed, then renewed or canceled, by the government (O'Brien & Devarics, 2010). The early British findings suggest that mixed schools were better placed to meet the social and educational needs of young people (Dale, 1974). The results of these studies have been inconsistent, with some providing support for the benefits of mixed schools (Marsh, 1989), while others support single-sex education (Astin, 1977). Student–teacher ratio is the number of students who attend a school divided by the number of teachers in the institution. For example, a student–teacher ratio of 10:1 indicates that there are 10 students for every one teacher. The term can also be reversed to create a teacher–student ratio (Ajani & Akinyele, 2014). The average number of students per class is 24 for each teacher and according to education indicators in focus the average is 23[2]. A canteen is a place where food is prepared and eaten and are used to serve food on an institutional level, militaries, school and large offices use canteen to meet the food requests of their work forces and student (Adaku & Anyanwu,2015). Instructional materials consist of visual, prints, graphics, electronic, projectiles and audiovisuals (Inyang & Abia, 1998) multimedia and laboratories. A teacher uses these facilities to achieve his/her set objectives (Mbipom, 2000). Alongside with cognitive knowledge, education should also develop moral aesthetic, physical and practical capacities (Lauglo, 2005). It also attracts more students but have a lower teacher-student ratio with larger class size (Lai *et al.*, 2007). One study indicates a reduction in class

[1] Online at: https://www.oecd.org/pisa/pisaproducts/pisainfocus/48482894.pdf
[2] OECD 2012 Education Indicators in Focus – 2012/09 (November)

Table 2. Description of Input and Output

Variable	Explanation
First-Stage Variable	
DEA Input	
clroom	Total number of classrooms in school
TSR	Total specialist rooms; libraries, art, design, gym, lecture etc.
TOR	Total other rooms; kitchen, mess, stores, preparation, etc.
TWS	Total workshops; wood, metal, mechanics, etc.
TNL	Total number of laboratories; biology, chemistry, physics, computer.
TE	Total equipment; TV, radio, projector, photocopying machines, etc.
TRF	Total recreational facilities; football, volleyball, tennis, swimming etc.
TSRB	Total number of subject reading books; English, French, etc.
THC	Total health and safety to cater for students; Fire extinguishers, first aids box, adapted toilets, etc.
ICT	Total number of information and communication technology facilities; computers, telephones, internet, websites, wires, networks, etc.
TACA	Total number of academic staffs, teachers
TADM	Total number of administrative staffs
Student	Total number of students in school
DEA Model Output	
% passes in SC	Overall % pass at school certificate examination in 2016
% passes in HSC	Overall % pass at higher school certificate examination 2016
Second-Stage Variables	
zone 1	Secondary schoolsof zone 1
zone 2	Secondary schools of zone 2
zone 3	Secondary schools of zone 3
zone 4	Secondary schools of zone 4
type	State or private secondary schools
boys	Single sex boys'secondary schools
girls	Single sex girls'secondary schools
mixed	Mixed sex secondary schools
studteacher	Number of teachers divide by number of students
studclass	Number of students divide by number of classrooms
canteen	Number of canteens in colleges
stute	Number of students divide by number of technological equipment
Efficiency Scores	
effc	Constant return to scale efficiency scores
effv	Variable return to scale efficiency scores

size (student-teacher ratio) contributes to student learning (Darling-Hammond & Snyder, 2000). However, another research shows that class size has a little impact on students' performance (Rivkin, 2005).

METHODOLOGY

In this paper we present the method by which efficiency targets for individual schools within the education system might be set using the DEA approach. We demonstrate the effects by using a dataset of 141 secondary schools in Mauritius for the year 2016 as only these schools have common outputs for SC (School Certificate) and HSC (Higher School Certificate). The statistics regarding location (zone), type of school, gender, teacher student ratio, student class ratio, canteen, technical equipment and other school facilities were selected as inputs in order to explain efficiency. The outputs were the overall % passes for SC and HSC cohorts.

The results from the DEA analysis are then corrected to account for possible measurement error in the data. This is done by "stripping" the best-performing colleges out of the DEA analysis and re- running the model (Nillesen & Pollitt, 2010). This will give a sense of the stability of the results. In the local context, the best schools are referred to as "academies" and the official list comprises of 12 schools and these schools are supposed to accommodate the incoming best cohorts of grade 10 student in 2021 after the national exam of 2020 in the new education system. Robustness of the efficiency scores estimators encourages a second stage analysis of the determinants of efficiency. The DEA inputs, output and second stage variables are summarized in **Table 2**.

Table 3. Summary Statistics of First Stage Variables (n=141)

Variable	Mean	Std. Dev.	Min	Max
Input:				
clroom	29.674	10.070	7	78
TSR	9.496	3.828	2	21
TOR	0.766	0.997	0	4
TWS	6.177	2.129	0	12
TNL	42.447	21.352	2	112
TE	7.837	6.353	0	35
TRF	1762.241	1975.963	0	10893
TSRB	4846.851	6017.816	0	48118
THC	26.454	10.987	2	63
ICT	202.262	126.518	33	627
TACA	55.525	20.072	7	99
TADM	58.553	18.210	3	99
Student	700.965	311.713	62	2037
Output:				
% passes in SC	67.006	24.998	11.76	100
% passes in HSC	66.390	21.347	4	100

Model Specification

This study uses DEA to estimate the technical, scale and return to scale. It uses linear programming to build the efficient frontier with the best performing observations of the sample under investigation, so that the frontier provides a measure of its efficacy (Nillesen & Pollitt 2010). The performance of a school to the frontier gives a measure of its efficacy. DEA also enables to assess under which returns to scale each school operates and to calculate their scale inefficiency. Calculating efficiency under the assumptions of constant returns to scale (CRS) gives the 'overall technical efficiency score', whereas assuming variable returns to scale (VRS) allows calculating one component of this total efficiency score, namely the '*pure technical efficiency*'. The latter captures the school management practices, while the residual between the total technical efficiency and pure technical efficiency indicates whether the school functions under optimum school size. This residual is called '*scale efficiency*'. The estimated efficiency scores lie between 0 and 1 and a score of one implies that a school operates under fully efficient conditions. Thus, the input-oriented DEA (minimizing input utilization to get a particular output level) are used to in estimating both CRS and VRS models.

Data

The data for the study was received from two online sources from the Mauritius Examination Syndicate and Statistics Mauritius. All the data are for the year 2016 only across secondary schools in Mauritius and it comprises both private and state secondary schools. This cohort consists of 159 schools but only 141 have been selected for this study as they have outputs for school certificates and higher school certificates and one school has been omitted due to unavailability of detailed statistics regarding school facilities.

Table 3 presents the summary statistics for the first stage data used in this paper. The average number of classrooms per school is about 30. The minimum total specialist rooms are two with a maximum of 21. About 45 % of the schools have other rooms like kitchen, mess and stores. The majority of schools are equipped with workshops and all school has at least two laboratories. Only about 4 % schools are not equipped with TV, radio, projector etc. and about 96% of the schools have recreational facilities. The average number of subject reading books in libraries is 4847 and all schools have healthcares with a maximum of 63. Information and communication technology facilities englobes all the schools and the average number of academic staffs is 56 per school. The lowest number of administrative staffs is 3 and the lowest school population is 62. Only about 6 % of the schools have 100% pass at SC level and only one school has a 100% note at HSC level.

Table 4 gives the efficiency scores base on inputs and outputs of respective secondary schools. The mean efficiency is estimated at 0.871 (assuming constant return to scale) and 0.909 (assuming variable return to scale); which means that the total inefficiency is 13% and 9% respectively. The efficiency ranges from 0 to 1. The country ranking is represented in **Table 5** and the efficiency ranges from 56% to 100%. On average, efficient schools could increase their net percentage performance rate by this amount without any additional spending.

Table 4. Efficiency Scores

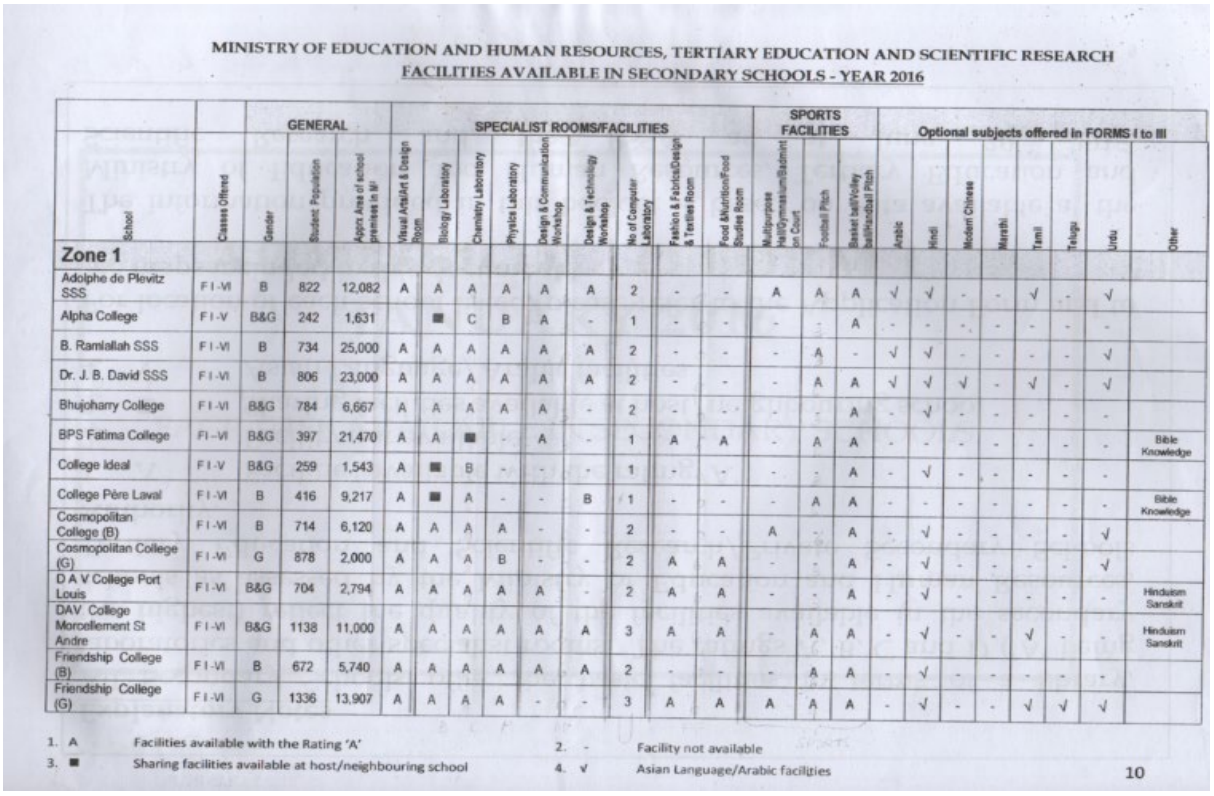
Name of schools	Model 1 CRS		SE	Model 2 VRS		RTS
	Efficiency	Ranking		Efficiency	Ranking	
Adolphe Deplevitz SSS	0.77	103	0.949	0.78	115	DRS
Adventist College	1	1	1.000	1	1	CRS
Aleemiah (Boys) College	1	1	1.000	1	1	CRS
Aleemiah Girls College	1	1	1.000	1	1	CRS
B Ramlallah SSS	0.89	84	0.908	0.98	87	IRS
Bambous State Secondary School	1	1	1.000	1	1	CRS
Beau Bassin SSS	1	1	1.000	1	1	CRS
Beckenham College	1	1	1.000	1	1	CRS
Bel Air SSS	0.64	123	0.985	0.65	132	IRS
Belle Rose SSS	0.82	94	0.953	0.86	107	IRS
Bhujoharry College	0.63	124	0.875	0.88	103	IRS
Bon Acceuil State College	1	1	1.000	1	1	CRS
Bps College	0.73	109	0.986	0.74	119	DRS
Bps Fatima College	1	1	1.000	1	1	CRS
Camp De Masque State College	0.58	129	1.000	0.58	136	CRS
City College Ltd	0.76	104	0.680	1	1	IRS
College De La Confiance	0.65	121	1.000	0.65	132	CRS
College Du Saint Esprit Riviere Noire	1	1	1.000	1	1	CRS
College Du St Esprit	1	1	1.000	1	1	CRS
College Pere Laval	1	1	1.000	1	1	CRS
College Sainte Marie	1	1	1.000	1	1	CRS
Cosmopolitan College (Girls)	0.79	100	1.000	0.99	86	CRS
Cosmopolitan College Boys	0.58	129	0.944	0.89	101	IRS
Curepipe College	0.61	125	0.924	0.66	130	IRS
Darwin College	0.69	114	1.000	0.58	136	CRS
Dav College Morc. St Andre	0.74	108	1.000	1	1	CRS
Dayanand Anglo Vedic College	1	1	1.000	1	1	CRS
Doha Secondary School	1	1	1.000	1	1	CRS
Dr James Burty David SSS	1	1	1.000	1	1	CRS
Dr Maurice Cure SSS*	1	1	1.000	1	1	CRS
Dr Regis Chaperon SSS	0.95	76	1.000	0.96	92	CRS
Droopnath Ramphul State College*	1	1	1.000	1	1	CRS
Dunputh Lallah SSS	1	1	1.000	1	1	CRS
Ebene SSS	1	1	1.000	1	1	CRS
Ebene SSS (Boys)	0.97	74	0.970	1	1	IRS
Eden College (Boys)	1	1	1.000	1	1	CRS
Eden College Girls	1	1	1.000	1	1	CRS
Emmanuel Anquetil SSS	0.82	94	0.943	0.87	104	IRS
Floreal SSS	1	1	1.000	1	1	CRS
Forest Side SSS*	1	1	1.000	1	1	CRS
Forest Side SSS(Boys)	0.71	111	0.986	0.72	120	IRS
France Boyer De La Giroday SSS	1	1	1.000	1	1	CRS
Friendship College Boys	0.93	78	1.000	1	1	CRS
Friendship College Girls	0.57	132	0.853	0.68	126	IRS
Full Day School	0.56	133	0.560	1	1	IRS
Full Day School Ltd Rose Hill	1	1	1.000	1	1	CRS
Gaetan Raynal State College	1	1	1.000	1	1	CRS
GMD Atchia State College*	1	1	1.000	1	1	CRS
Goodlands SSS Boys	0.68	118	0.986	0.69	125	IRS
Hamilton College Boys	0.67	120	1.000	0.65	132	CRS
Hamilton College Girls	0.54	136	0.763	0.76	117	IRS
Hindu Girls College	0.68	118	0.971	0.7	124	DRS
Imperial College	0.83	91	1.000	0.82	111	CRS
International College	0.98	71	0.990	1	1	IRS
Islamic Cultural College	1	1	1.000	1	1	CRS
Islamic Cultural College Form Six	1	1	1.000	1	1	CRS
J M Frank Richard SSS	0.81	97	1.000	0.81	113	CRS
John Kennedy College*	0.94	77	0.979	0.96	92	DRS
Keats College	0.35	139	0.946	0.37	141	IRS
La Gaulette SSS	1	1	1.000	1	1	CRS
Labourdonnais College	1	1	1.000	1	1	CRS
Lady Sushil Ramgoolam SSS	0.78	102	1.000	1	1	CRS
Le Lycee Mauricien	1	1	1.000	1	1	CRS
London College	0.79	100	1.000	1	1	CRS
Loreto College Bambous Virieux	0.69	114	0.908	0.76	117	IRS
Loreto College Curepipe	0.86	87	0.920	1	1	DRS
Loreto College Mahebourg	0.98	71	0.980	1	1	DRS
Loreto College Port Louis	1	1	1.000	1	1	CRS
Loreto College Rose Hill	1	1	1.000	1	1	CRS
Loreto College Saint Pierre	0.97	74	1.000	0.97	89	CRS
Loreto Colllege	0.83	91	0.837	0.92	98	DRS
M. Sungeelee SSS	0.55	134	0.948	0.58	136	IRS
Mahatma Gandhi Institute Secondary School*	1	1	1.000	1	1	CRS
Mahatma Gandhi Secondary School Moka	1	1	1.000	1	1	CRS

Note: *denotes the best national secondary school.

Table 4 (continued). Efficiency Scores

Name of schools	Model 1 CRS		SE	Model 2 VRS		RTS
	Efficiency	Ranking		Efficiency	Ranking	
Mahatma Gandhi Secondary School Nouvelle France	1	1	1.000	1	1	CRS
Mahatma Gandhi Secondary School Flacq	1	1	1.000	1	1	CRS
Mauricia Institute	1	1	1.000	1	1	CRS
Mauritius College	1	1	1.000	1	1	CRS
Mauritius College (Boys)	0.58	129	0.753	0.77	116	IRS
Mayflower College	0.59	128	0.879	0.66	130	IRS
Medco Alex Bhujoharry	1	1	1.000	1	1	CRS
Mgss (Solferino)	1	1	1.000	1	1	CRS
Modern College	0.71	111	0.958	0.71	122	DRS
Muslim Girls College	1	1	1.000	1	1	CRS
N Saddul College	0.76	104	0.925	0.67	128	IRS
New Devton College	0.55	134	1.000	1	1	CRS
New Educational College	0.45	138	0.865	0.52	140	IRS
New Eton College	0.76	104	0.817	0.93	97	IRS
Notre Dame College	0.89	84	0.989	0.9	100	DRS
Ocep The Open College	0.61	125	0.629	0.89	101	IRS
Ocep The Open College	0.47	137	0.701	0.67	128	IRS
Pailles SSS	1	1	1.000	1	1	CRS
Palma SSS	0.85	88	0.988	0.86	107	IRS
Pamplemousses SSS	1	1	1.000	1	1	CRS
Patten College (Girls)	0.88	86	1.000	1	1	CRS
Patten College (Boys)	0.9	81	0.957	0.94	95	IRS
Phoenix SSS	1	1	1.000	1	1	CRS
Piton State	1	1	1.000	1	1	CRS
Port Louis North SSS	0.72	110	0.986	0.72	120	DRS
Port Louis (Girls) SSS	1	1	1.000	1	1	CRS
Presidency College (Boys)	0.69	114	0.793	0.87	104	IRS
Professor Basdeo Bissoondoyal College Boys	0.6	127	0.984	0.61	135	IRS
Professor Basdeo Bissoondoyal College Girls	0.81	97	0.988	0.82	111	IRS
Professor Hassan Raffa SSS	1	1	0.887	0.97	89	IRS
Pt Sharma Jugdambi SSS	1	1	1.000	1	1	CRS
Quatre- Bornes SSS	0.91	80	0.958	0.95	94	IRS
Quartier Militaire SSS	1	1	1.000	1	1	CRS
Queen Elizabeth College*	1	1	1.000	1	1	CRS
R. Seeneevassen SSS	1	1	1.000	1	1	CRS
Rabindranath Tagore Secondary School	0.9	81	0.810	1	1	DRS
Rajcoomar Gujadhur SSS	1	1	1.000	1	1	CRS
Ramsoondar Prayag SSS	0.69	114	0.972	0.71	122	IRS
Riviere Des Anguilles State College	0.93	78	0.840	0.94	95	IRS
Royal College Curepipe*	1	1	1.000	1	1	CRS
Royal College Port Louis*	1	1	1.000	1	1	CRS
Saint Andrews School	0.98	71	0.980	1	1	DRS
Saint Aubin State Secondary School	0.83	91	1.000	0.83	110	CRS
Saint Bartholomew's College	0.85	88	0.735	0.98	87	IRS
Saint Mary's College	1	1	1.000	1	1	CRS
Sebastopol SSS	1	1	1.000	1	1	CRS
Seewa Bappoo SSS	1	1	0.990	1	1	IRS
Shrimati Indira Gandhi SSS	0.65	121	0.956	0.68	126	IRS
Sinadree Viransawmy State Secondary School	0.81	97	0.964	0.84	109	IRS
Sir A.R Mohamed SSS*	1	1	1.000	1	1	CRS
Sir Abdool Raman Osman State College	0.84	90	0.948	0.97	89	DRS
Sir Leckraz Teelock	1	1	1.000	1	1	CRS
Sodnac SSS	1	1	1.000	1	1	CRS
Sookdeo Bissoondoyal State College*	0.9	81	0.900	1	1	DRS
Soondur Munrakhun College	0.7	113	1.000	1	1	CRS
St Helena College	1	1	1.000	1	1	CRS
St Joseph's College	0.75	107	0.975	0.8	114	DRS
St Mary's West College	1	1	1.000	1	1	CRS
Swami Sivananda SSS	1	1	1.000	1	1	CRS
Swami Vivekananda SSS	1	1	1.000	1	1	CRS
Terre Rouge SSS	0.82	94	1.000	1	1	CRS
Thanacody College	1	1	1.000	1	1	CRS
Triolet SSS	0.77	103	0.924	0.92	98	IRS
Unity College	1	1	1.000	0.87	104	CRS
Universal College	0.35	139	0.630	0.54	139	IRS
Vacoas SSS	1	1	1.000	1	1	CRS
Windsor College Girls	1	1	1.000	1	1	CRS

Note: *denotes the best national secondary school.



MINISTRY OF EDUCATION AND HUMAN RESOURCES, TERTIARY EDUCATION AND SCIENTIFIC RESEARCH
FACILITIES AVAILABLE IN SECONDARY SCHOOLS - YEAR 2016

School	Classes Offered	GENERAL: Gender	GENERAL: Student Population	GENERAL: Appox Area of school premises in M²	SPECIALIST ROOMS/FACILITIES: Visual Arts/Art & Design Room	Biology Laboratory	Chemistry Laboratory	Physics Laboratory	Design & Communication Workshop	Design & Technology Workshop	No of Computer Laboratory	Fashion & Fabrics/Design & Textiles Room	Food &Nutrition/Food Studies Room	SPORTS FACILITIES: Multipurpose Hall/Gymnasium/Badminton Court	Football Pitch	Basket ball/Volley ball/Handball Pitch	Optional subjects offered in FORMS I to III: Arabic	Hindi	Modern Chinese	Marathi	Tamil	Telugu	Urdu	Other
Zone 1																								
Adolphe de Plevitz SSS	FI-VI	B	822	12,082	A	A	A	A	A	A	2	-	-	A	A	A	√	√	-	-	√	-	√	
Alpha College	FI-V	B&G	242	1,631		■	C	B	A	-	1	-	-	-	-	A	-	-	-	-	-	-	-	
B. Ramlallah SSS	FI-VI	B	734	25,000	A	A	A	A	A	A	2	-	-	-	A	-	√	√	-	-	-	-	√	
Dr. J. B. David SSS	FI-VI	B	806	23,000	A	A	A	A	A	A	2	-	-	-	A	A	√	√	√	-	√	-	√	
Bhujoharry College	FI-VI	B&G	784	6,667	A	A	A	A	A	-	2	-	-	-	-	A	-	√	-	-	-	-	-	
BPS Fatima College	FI-VI	B&G	397	21,470	A	A	■	-	A	-	1	A	A	-	A	A	-	-	-	-	-	-	-	Bible Knowledge
College Ideal	FI-V	B&G	259	1,543	A	■	B	-	-	-	1	-	-	-	-	A	-	√	-	-	-	-	-	
College Père Laval	FI-VI	B	416	9,217	A	■	A	-	-	B	1	-	-	-	A	A	-	-	-	-	-	-	-	Bible Knowledge
Cosmopolitan College (B)	FI-VI	B	714	6,120	A	A	A	A	-	-	2	-	-	A	-	A	-	√	-	-	-	-	√	
Cosmopolitan College (G)	FI-VI	G	878	2,000	A	A	A	B	-	-	2	A	A	-	-	A	-	√	-	-	-	-	√	
D A V College Port Louis	FI-VI	B&G	704	2,794	A	A	A	A	A	-	2	A	A	-	-	A	-	√	-	-	-	-	-	Hinduism Sanskrit
DAV College Morcellement St Andre	FI-VI	B&G	1138	11,000	A	A	A	A	A	A	3	A	A	-	A	A	-	√	-	-	√	-	-	Hinduism Sanskrit
Friendship College (B)	FI-VI	B	672	5,740	A	A	A	A	A	A	2	-	-	-	A	A	-	√	-	-	-	-	-	
Friendship College (G)	FI-VI	G	1336	13,907	A	A	A	A	-	-	3	A	A	A	A	A	-	√	-	-	√	√	√	

1. A Facilities available with the Rating 'A'
2. - Facility not available
3. ■ Sharing facilities available at host/neighbouring school
4. √ Asian Language/Arabic facilities

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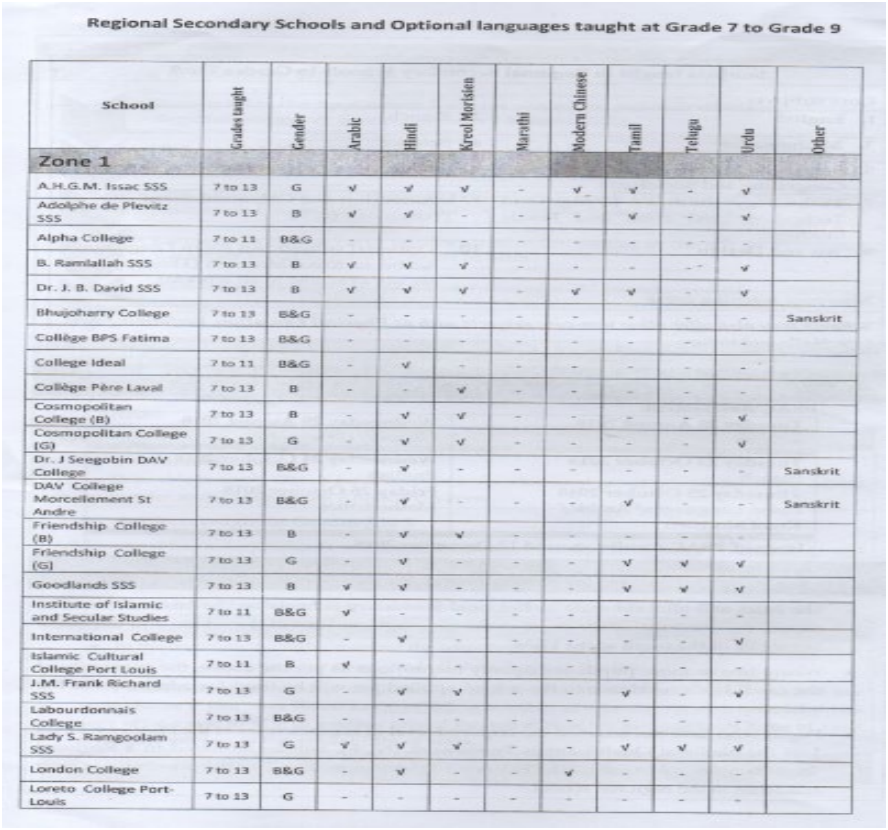
Figure 1. Grading of School Facilities in 2016

An efficiency score of 1 indicates that the secondary school is operating the most efficiently under the specified input and output variables. Scores below 1 indicate lower or inefficient secondary schools. In Mauritius, parents, teachers and students do not have efficiency scores at their disposal when considering the choice of secondary schools. Parents were given '*Admission to form 1- 2016 notes for guidance*' as shown in **Figure 1** to learn about secondary school facilities while making school choice prior to enrolment at form 1 (grade 7 as from 2017). For vacancies in the best national secondary schools (future academies), the best performance grades at grade 6 were considered at national level up to 2016. From 2017 onwards, the 12 academies will be operational only after grade 9 national examinations as from 2020 and grade 6 students are admitted in other secondary schools (141) based on performance merits vacancies and parental choice. In the new '*Admission to form 1 (grade 7) 2019 - notes for guidance*' as shown in **Figure 2** no information about school facilities are available and the only information available is on gender and subjects choices available in option languages. Therefore, the use of efficiency scores in admission form can be very helpful and informative. The efficiency scores can be made public[3] as it is the case with percentage wise rankings of all secondary schools in decreasing order as shown in **Figures 3** and **4**. It is interesting to note that the majority of academies have efficiency scores of 1 except for John Kennedy College (under both CRS and VRS) and Soookdeo Bissoondoyal state college (under CRS). About 62% of secondary schools not listed as best secondary schools have efficiency score 1. Therefore, the use of this efficiency score list is very helpful in making the right choice as parents tend to choose the best schools. Parental decision is usually a conscious, intentional and considered decision, made in the presence of substantial information (Allen *et al.*, 2014). Most parents prefer private schools due to good educational facilities and a conducive learning environment (Njoki, 2017). The next step involves the second stage analysis of the DEA approach and **Table 6** gives the summary statistics.



Regional Secondary Schools and Optional languages taught at Grade 7 to Grade 9

School	Grades taught	Gender	Arabic	Hindi	Kreol Morisien	Marathi	Modern Chinese	Tamil	Telegu	Urdu	Other
Zone 1											
A.H.G.M. Issac SSS	7 to 13	G	√	√	√	-	√	√	-	√	
Adolphe de Plevitz SSS	7 to 13	B	√	√	-	-	-	√	-	√	
Alpha College	7 to 11	B&G	-	-	-	-	-	-	-	-	
B. Ramlallah SSS	7 to 13	B	√	√	√	-	-	-	-	√	
Dr. J. B. David SSS	7 to 13	B	√	√	√	-	√	√	-	√	
Bhujoharry College	7 to 13	B&G	-	-	-	-	-	-	-	-	Sanskrit
Collège BPS Fatima	7 to 13	B&G	-	-	-	-	-	-	-	-	
College Ideal	7 to 11	B&G	-	√	-	-	-	-	-	-	
Collège Père Laval	7 to 13	B	-	-	√	-	-	-	-	-	
Cosmopolitan College (B)	7 to 13	B	-	√	√	-	-	-	-	√	
Cosmopolitan College (G)	7 to 13	G	-	√	√	-	-	-	-	√	
Dr. J Seegobin DAV College	7 to 13	B&G	-	√	-	-	-	-	-	-	Sanskrit
DAV College Morcellement St Andre	7 to 13	B&G	-	√	-	-	-	√	-	-	Sanskrit
Friendship College (B)	7 to 13	B	-	√	√	-	-	-	-	-	
Friendship College (G)	7 to 13	G	-	√	-	-	-	√	√	√	
Goodlands SSS	7 to 13	B	√	√	-	-	-	√	√	√	
Institute of Islamic and Secular Studies	7 to 11	B&G	√	-	-	-	-	-	-	-	
International College	7 to 13	B&G	-	√	-	-	-	-	-	√	
Islamic Cultural College Port Louis	7 to 11	B	√	-	-	-	-	-	-	-	
J.M. Frank Richard SSS	7 to 13	G	-	√	√	-	-	√	-	√	
Labourdonnais College	7 to 13	B&G	-	-	-	-	-	-	-	-	
Lady S. Ramgoolam SSS	7 to 13	G	√	√	√	-	-	√	√	√	
London College	7 to 13	B&G	-	√	-	-	√	-	-	-	
Loreto College Port-Louis	7 to 13	G	-	-	-	-	-	-	-	-	

Figure 2. Optional Subjects in 2017

MAURITIUS EXAMINATIONS SYNDICATE

Cambridge School Certificate 2016 - Performance by School

	Total Examined	Passed	*% Pass*
Dar-Ul-Ma'Arif Secondary School	6	6	***100.00***
Dr Maurice Cure State College	148	148	***100.00***
Droopnath Ramphul State College	109	109	***100.00***
Forest Side State Secondary School (Girls)	109	109	***100.00***
France Boyer De La Giroday State Secondary School	112	112	***100.00***
Islamic Cultural College Form Vi (V Des Pretres)	2	2	***100.00***
Mahatma Gandhi Institute Moka	96	96	***100.00***
Mahatma Gandhi Secondary School Moka	104	104	***100.00***
Morning Star School	3	3	***100.00***
Queen Elizabeth College	142	142	***100.00***
G M D Atchia State College	128	127	***99.22***

Figure 3. Top secondary schools % pass in descending order 2016 [3]

Full Day School Ltd Curepipe	43	6	***13.95***
Unity College	69	9	***13.04***
Full Day School Ltd - Rose Hill	34	4	***11.76***
Victoria College	11	1	***9.09***
Medco Cassis Secondary School (Girls)	7	0	***0.00***
Merton College	10	0	***0.00***

Figure 4. Least performing secondary school % pass in descending order 2016 [3]

[3] Online at : http://mes.intnet.mu/English/Pages/statistics_pages/sc_statistics.aspx

Table 5. Summary Statistics of Second Stage Variables (n=141 and n=129)

Variable	Mean		Std. Dev.		Min		Max	
Dependent:	n=141	n=129	n=141	n=129	n=141	n=129	n=141	n=129
effc	0.882	0.875	0.166	0.166	0.34	0.35	1	1
effv	0.915	0.909	0.183	0.140	0.37	0.37	1	1
Independent:								
zone 1	0.312	0.310	0.465	0.464	0	0	1	1
zone 2	0.234	0.225	0.424	0.419	0	0	1	1
zone 3	0.241	0.240	0.429	0.429	0	0	1	1
type	0.475	0.426	0.501	0.496	0	0	1	1
boys	0.326	0.310	0.471	0.464	0	0	1	1
girls	0.348	0.341	0.478	0.476	0	0	1	1
studteacher1	14.909	14.479	9.972	9.961	0.019	1.253	52.909	52.909
studclass	23.835	22.877	0.957	7.167	7	7	106.8	41.571
canteen	0.950	0.946	0.218	0.227	0	0	1	1
stute	24.427	23.336	30.006	28.770	3.306	3.306	237	237

Table 5 shows the summary statistics of the second stage data used in this paper. The Spearman's rho shows that both efficiencies (CRS and VRS) are independent. There are 129 secondary schools excluding the best national schools. Dummies zone 1, zone 2 and zone 3 have about 31%, 24% and 24% of schools respectively when n=141 and stripping do not cause a major change in the percentages (31%, 23% and 26%). There are about 42.6% of state schools and 57.4% private schools and the school gender distributions are as follows: 31% boys, 34 % girls and 35% mixed. The average teacher-student ratio is 15 and the average student -class ratio is about 24. Only about 5 % of the schools do not have a canteen and the student per equipment ratio is on average 24. The mean efficiency scores are 0.882 and 0.915 under CRS and VRS respectively.

RESULTS

The results are based on two samples, with (n = 141) and without (n = 129) the "*best national*" schools. Preliminary test are mainly based on OLS as shown in **Table 6**. The models display reasonable goodness-of-fit based on the adjusted-R^2 and passes most of the diagnostic tests. They include the variance inflation factor (VIF), the Breusch and Pagan (1979) and White (1980) heteroskedasticity tests, Jarque and Bera normality test (1987) and the omitted-variable bias regression equation specification error test (RESET) of DeBenedictis and Giles (1998). The VIF is found to be lower than 5 and this implies no severe multicollinearity. A value of 5 or 10 indicates a multicollinearity problem (O'Brien, 2007). Heteroskedasticity is detected but does not cause bias or inconsistency estimators. As such, robust standard errors are computed. Although the normality assumption of residuals is rejected at the 1% significance level, asymptotic results can still hold for a wider class of distributions (Cramon-Taubadel, 1998). The diagnostic RESET statistics detect model misspecification and therefore results for the effv model should be interpreted with caution (David, 2007).

Table 6. OLS models

Variables	**Effc**	**Effv**
zone		
zone 1	-0.066	-0.036
	(0.037)$^{+}$	(0.031)
zone2	-0.108	-0.109
	(0.040)*	(0.033)*
zone 3	- 0.135	- 0.104
	(0.040)*	(0.033)*
type	0.053	0.053
	(0.029)$^{+}$	(0.029)$^{+}$
boys	0.006	0.006
	(0.037)	(0.037)
girls	0.077	0.077
	(0.036)$^{+}$	(0.036)$^{+}$
studteacher 1	0.311	0.311
	(0.168)$^{+}$	(0.168)$^{+}$
studclass	0.001	0.001
	(0.001)	(0.001)
canteen	-0.002	-0.002
	(0.063)	(0.063)
stute	0.001	0.001
	(0.0004)$^{+}$	(0.0004)$^{+}$
Intercept	0.821	0.821
	(0.081)*	(0.081)*
Observations	141	141
τ^2	21.84	20.32
Adj-R^2	15.83	14.19
F-Statistics	3.63	3.31
Mean VIF	1.49	1.49
Wald test	36.323[0.0001]*	33.148[0.0003]*
F-Test	3.632[0.0003]*	3.314[0.0007]*
Jarque-Bera	12.71 [0.002]*	32.87 [0.000]*
White Test	58.01[0.233]	63.32[0.115]
DeBenedictis-Giles	1.091[0.372]	2.486 [0.047] $^{+}$
Breusch-Pagan	22.10[0.0000]*	25.61[0.0000]*

Note: *, $^{+}$ and ‡are 1%, 5% and 10% respectively.

The spearman's rho correlation between CRS and VRS gives a value of 0.908 for 141 observations with p-value = 0.000 indicating that both are independent. The OLS reveals that the variable zone, type of school, gender, teacher student ratio and student equipment ratio are significant under both CRS and VRS models. The results are further interpreted using the Tobit models and the results are given in **Table 7**.

Table 7. Tobit models

Variable	Effc		Effv	
Zone				
zone 1	-0.116	-0.193	-0.082	-0.168
	(0.073)	(0..073) *	(0.071)	(0.073) +
zone2	-0.203	-0.283	-0.218	-0.289
	(0.078) ‡	(0.076)*	(0.076) +	(0.079)*
zone 3	- 0.248	- 0.274	- 0.218	- 0.272
	(0.074) +	(0.077)*	(0.072)*	(0.078)*
state	0.095	0.129	0.087	0.074
	(.053) ‡	(0.057) +	(0.050) ‡	(0.057)
Gender				
boys	- 0.041	-0.053	-0.100	-0.087
	(0.067)	(0.065)	(0.063)	(0.066)
girls	0.139	0.142	0.084	0.116
	(0.073) ‡	(0.069) +	(0.070)	(0.073)
studteacher1	0.761	0.665	0.596	0.558
	(0.364) +	(0.346) ‡	(0.322)	(0.340)
studclass	0.001	-0.004	0.001	-0.003
	(0.003)	(0.004)	(0.003)	(0.005)
canteen	0.018	-0.017	-0.083	-0.086
	(0.143)	(0.155)	(0.165)	(0.002)
stute	0.005	0.005	0.005	0.006
	(0.001) *	(0.002) *	(0.002) *	(0.002) *
Intercept	0.844	1.025	1.032	1.170
	(0.179) *	(0.203) *	(0.200) *	(0.224) *
Observations	141	129	141	129
F-test	4.56	5.27	3.98	4.25
Pseudo-R^2	0.293	0.371	0.292	0.325

In the Tobit models there are no differences between the coefficient values and their corresponding marginal effects irrespective of sample sizes. The coefficient differs after stripping the 12 best secondary schools and the sample changes n=141 to n=129.

ANALYSIS OF RESULTS

The results of the DEA model are presented in **Table 6** and **7**. The table includes normal OLS regressions (n=141), Tobit regressions (n=141 and n=129). The mean efficiency is estimated at 0.871 (CRS) and 0.909 (VRS) meaning that the total inefficiency is 13% and 9% respectively. The efficiency ranges from 0 to 1. The country ranking is represented in **Table 5** and the efficiency ranges from 56% to 100%. On average, efficient schools could increase their net percentage performance rate by this amount without any additional spending. The results from both models indicate negative significant results in terms of zones 2 and 3 relative to zone 4 for with sample size 141. However, after stripping to 129, zone 1 too becomes significant. This can be explained on the basis of the number of schools present in the respective zones and the location of schools in terms of rural and urban. For instance, zone 4 consists of only 30 schools compared to 44, 34 and 34 for zones 1, zone 2 and zone 3 respectively. Besides, most of the schools in zone 4 are situated in the central plateau with urban areas except for La Gaulette SSS. This school has the lowest % passes at SC (29%) and HSC (50%) for that particular year. Both Tobit models reveal positive significant impacts of public schools on academic output relative to private schools with sample size 141 but after stripping to 129 only the CRS model is significant at 5%. According to Uline and Tschannen-Moran (2008) there is a strong and positive relationship between quality of school facilities and student achievement in English and Mathematics. Epumepu and Igbinedion (2011) also reveal that the percentage performance trend of public schools is higher than those of the private schools both males and females. Besides, a study conducted in the local context confirms this statement (Jaunky & Nauzeer, 2017). Both models indicate positive significant results in terms for female single sexed schools compared to mixed schools. An increase in girls' schools is more likely to cause about 14 % increase in academic performance. A meta-analysis indicates small gender differences in mathematics performance favouring females over males but this difference is decreasing with time (Hyde *et al.*, 1990). Zhang and Manon (2000) find that males have a larger variance in mathematics scores than females but they tend to outperform

males among the low-achieving students. A teacher in the classroom is a main device for bringing about qualitative improvement in teaching and learning activities. Such quality is making best use of where there are enabling and caring environments with pupils participating actively in the course of action and where pupils, teachers and schools have opportunities for institutional growth (Kambuga, 2013). The average number of students per class is 24 for each teacher and according to another education indicator in focus the average is 23[4]. For instance, Doha secondary and MGSS Solferino are in line with this average but two schools namely Eden College and Muslim Girls College have inferior ratio. Results from both models indicate highly positive significant impacts of student and technical equipment ratio. This shows that as the number of students increase per technical equipment the efficiency is higher in the local context. For example, Saint Mary's College offer the highest technical support in terms of equipment and Keats College is the least equipped and their scale efficiencies are 1 and 0.946 respectively. However, the latter is showing an increasing return to scale meaning that compensation form other inputs are possible and in this specific case TRF (Total recreational facilities) and TSRB (Total number of subject reading books) overshadows technical equipment.

DISCUSSIONS AND POLICY IMPLICATIONS

With the new objectives set by the government under the nine-year schooling context, a fair rotation of the teaching and non-teaching staff among the zones is highly recommended as zone 4 is biased relative to the other zones in terms of rural/urban location, the number of schools present. Gender seems to matter as far as academic output is concerned and indicators are not in support of mixed schools as girls underperform in co-schools. Therefore, it's highly recommended that the incoming academies in the nine-year schooling should be single sexed which is not the actual case and this may adversely impact academic performance especially for girls. The government's will to introduce the use of ICT below and at Primary School Achievement Certificate (PSAC) level is a positive move but the translation from "having" technical equipment to "using" technical equipment is necessary and this may be catalyzed by more frequent visits of the zone inspectors. The efficiency scale can be a major reference in attempts to shut down of colleges which has not been the case so far. Actually, very recently some private colleges have been revoked and compelled to stop functioning due to low student intakes and poor academic performances at school certificate levels and higher school certificate levels. Also, grants are given on the basis of school facilities and head of students and more funding indirectly means better facilities and service. However, this may not be the best human practice as closures are usually accompanied by resistance from the managerial side and redundancies of both teaching and non-teaching staffs occur. Therefore, the implication of efficiency scale can serve as an indicator for all colleges on a national level and hence the set up of a benchmark is necessary. Parents should be given an updated list of school facilities and their respective efficiency in order to get maximum information in doing the right choice of secondary school for their children. Besides, the sharing of good practices can be enhanced on a comparative basis and colleges may be encouraged to give better outputs on the basis of similar inputs. Lastly, colleges may be given targets based on average efficiency scores and this will provide incentives and enhance smooth upgrading at every level to achieve efficiency improvements.

RECOMMENDATIONS

The educational stakeholders are therefore advised to make use of the DEA approach in decision making. The funding of colleges should be on the basis of efficiency and not solely on head of students or universal packages which is actually the case. Besides, the government should ensure translation of inputs into maximum outputs by regular analysis on a yearly base. The efficient peers should be encouraged to share good practices on a national basis and serve as references to prioritize targets of inefficient colleges. Parents should be given additional information concerning return to scale efficiencies as it acts of as an "indicator package" of the schools as a whole taking into consideration most inputs and outputs.

CONCLUSIONS

This paper attempts to measure the efficiency scores of secondary schools in Mauritius. DEA proves to be an appropriate method to analyze efficiency of educational institutions. It is commonly accepted that the performance of a school can be attributed to both internal and external factors. Based on most of the empirical

[4] OECD 2012 Education Indicators in Focus – 2012/09 (November)

literature in schooling, the model of education has been modeled as a function where inputs (teaching-staffs, non-teaching staffs, school facilities, population) are combined in order to produce output (school performance). The efficiency score estimates seem to be robust and provides insight for further investigation using the variables which explain differences in efficiencies. CRS and VRS in DEA approaches are effective against the effect of outliers at the frontier. Information from the observed performance of schools will help those deemed relatively inefficient to improve their performance. This deep insight can be useful in developing strategies in order to improve the quality of education on a national scale.

Disclosure statement

No potential conflict of interest was reported by the authors.

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REFERENCES

Adaku, S.U., & Anyanwu, C. (2015). *Academic performance of students that eat in canteen and students that cook their food*.

Agasisti, T., & Pohl, C. (2012). Comparing German and Italian public universities: Convergence or divergence in the higher education landscape? *Managerial and Decision Economics*, *33*(2), 71-85. https://doi.org/10.1002/mde.1561

Ajani, I. R., & Akinyele, O. B. (2014). Effects of Student-Teacher Ratio on Academic Achievement of Selected Secondary School Students in Port Harcourt Metropolis, Nigeria. *Journal of Education and Practice, 24*(5), 100-106.

Ajayi, I. A., & Yusuf, M. A. (2010). School Plants Planning and Students' Learning Outcomes in South West Nigerian Secondary Schools. *International Journal of Education and Science, 2*(1), 47-53. https://doi.org/10.1080/09751122.2010.11890000

Aristovnik, A., & Obadić, A. (2014). Measuring relative efficiency of secondary education in selected EU and OECD countries: The case of Slovenia and Croatia. *Technological and Economic Development of Economy*, *20*(3), 419-433. https://doi.org/10.3846/20294913.2014.880085

Astin, A. W. (1977). *Four Critical Years. Effects of College on Beliefs, Attitudes, and Knowledge*.

Aubyn, M. S., Garcia, F., & Pais, J. (2009). *Study on the efficiency and effectiveness of public spending on tertiary education* (No. 390). Directorate General Economic and Financial Affairs (DG ECFIN), European Commission.

Barrett, P. S., & Zhang, Y. (2009). *Optimal learning spaces: Design implications for primary schools*.

Barro, R. J., & Lee, J. W. (2001). International data on educational attainment: updates and implications. *Oxford Economic papers*, *53*(3), 541-563. https://doi.org/10.1093/oep/53.3.541

Bradley, S., Johnes, G., & Millington, J. (2001). The effect of competition on the efficiency of secondary schools in England. *European Journal of Operational Research*, *135*(3), 545-568. https://doi.org/10.1016/S0377-2217(00)00328-3

Chodakowska, E. (2015). The future of evaluation of lower secondary schools' management. *Business, Management and Education*, *13*(1), 112-125. https://doi.org/10.3846/bme.2015.256

Cunha, M., & Rocha, V. (2012). On the efficiency of public higher education institutions in Portugal: an exploratory study. *University of Porto: FEP Working Paper*, (468).

Dale, R. R. (1974). *Mixed or single-sex school? Vol. 3, Attainment, attitudes and overview*.

Darling-Hammond, L., & Snyder, J. (2000). Authentic assessment of teaching in context. *Teaching and teacher education*, *16*(5-6), 523-545. https://doi.org/10.1016/S0742-051X(00)00015-9

Epumepu, E. A., & Igbinedion, V. I. (2011). A comparison of students' academic performance in business studies in public and private junior secondary school certificate examinations (JSSCE) in Ovia South West LGA of Edo State.

Grigoli, F., & Ley, E. (2012). *Quality of government and living standards: Adjusting for the efficiency of public spending*.

Gupta, S., & Verhoeven, M. (2001). The efficiency of government expenditure: experiences from Africa. *Journal of policy modeling*, *23*(4), 433-467. https://doi.org/10.1016/S0161-8938(00)00036-3

Huguenin, J. M. (2015). Determinants of school efficiency: The case of primary schools in the State of Geneva, Switzerland. *International Journal of Educational Management*, *29*(5), 539-562. https://doi.org/10.1108/IJEM-12-2013-0183

Hyde, J. S., Fennema, E., & Lamon, S. J. (1990). Gender differences in mathematics performance: a meta-analysis. *Psychological bulletin*, *107*(2), 139. https://doi.org/10.1037/0033-2909.107.2.139

Inyang-Abia, M. E. (1998). Local materials in science technology and methods of teaching, identification and utilization. *Proceedings of the 38th Annual Conference of STAN*, 64-67.

Jaunky, V. C., & Nauzeer, S. (2017). *Determinants of Secondary School Performance in Mauritius: A Cross-Sectional Approach*.

Jovinius, J. (2015). *An Investigation of the Effect of Geographical Location of Schools to the Students' Academic Performance: A Case of Public Secondary Schools in Muleba District* (Doctoral dissertation, The Open University of Tanzania).

Kambuga, Y. (2013). The Impact of Teacher-Pupil Ratio on Teaching-Learning Process in Primary Schools: Experiences from Tanzania. *International Journal of Education and Practice*, *1*(2), 14-25. https://doi.org/10.18488/journal.61/2013.1.2/61.2.14.25

Khan, P., & Iqbal, M. (2012). *Interdisciplinary journal of contemporary research in business, 4*(3), 211.

Koontz, H., & Weinrich, H. (2012). Management. A Global Perspective (12th Ed.), Ed. McGraw-Hill.

Lai, F., Sadoulet, E., & de Janvry, A. (2007). *The Effect of School and Teacher Quality on Student Performance.*

Lauglo, J. (2005). Vocationalised secondary education revisited. In *Vocationalisation of secondary education revisited* (pp. 3-49). Springer, Dordrecht. https://doi.org/10.1007/1-4020-3034-7_1

Marsh, H. W. (1989). *Effects of single-sex and coeducational schools: A response to Lee and Bryk*.

Mbipom, G. (2000). *Educational administration and planning*. Calabar: Glad Tidings Press Ltd.

Meunier, M. (2008). Are Swiss secondary schools efficient? In *Governance and Performance of Education Systems* (pp. 187-202). Springer, Dordrecht.

Nillesen, P., & Pollitt, M. (2010). Using regulatory benchmarking techniques to set company performance targets: the case of US electricity. *Competition and Regulation in Network Industries*, *11*(1), 50-84. https://doi.org/10.1177/178359171001100103

O'Brien, E. M., & Dervarics, C. (2010). Charter schools: Finding out the facts. *Center for Public Education*.

Odufowokan, B. A. (2011). School Plant Planning as a Correlate of Student's Academic Performance in South West Nigeria Secondary Schools. *International Journal of Business Administration, 2*(2), 41-47.

Rivkin, S. G., Hanushek, E. A., & Kain, J. F. (2005). Teachers, schools, and academic achievement. *Econometrica*, *73*(2), 417-458. https://doi.org/10.1111/j.1468-0262.2005.00584.x

Rundell, M. (2007). *Macmillan english dictionary for advanced learners*. Oxford: A & C Black Publishers Ltd.

Simar, L., & Wilson, P. W. (2007). Estimation and inference in two-stage, semi-parametric models of production processes. *Journal of econometrics*, *136*(1), 31-64. https://doi.org/10.1016/j.jeconom.2005.07.009

Soteriou, A. C., Karahanna, E., Papanastasiou, C., & Diakourakis, M. S. (1998). Using DEA to evaluate the efficiency of secondary schools: the case of Cyprus. *International Journal of Educational Management*, *12*(2), 65-73. https://doi.org/10.1108/09513549810204441

Webster, B. J., & Fisher, D. L. (2000). Accounting for variation in science and mathematics achievement: A multilevel analysis of Australian data Third International Mathematics and Science Study (TIMSS). *School Effectiveness and School Improvement*, *11*(3), 339-360. https://doi.org/10.1076/0924-3453(200009)11:3;1-G;FT339

Wolszczak, J. (2014). *An evaluation and explanation of (in) efficiency in higher education institutions in Europe and the US with the application of two-stage semi-parametric DEA*.

Wolszczak-Derlacz, J., & Parteka, A. (2011). Efficiency of European public higher education institutions: a two-stage multicountry approach. *Scientometrics*, *89*(3), 887. https://doi.org/10.1007/s11192-011-0484-9

Xu, H., & Liu, F. (2017). Measuring the efficiency of education and technology via DEA approach: Implications on national development. *Social Sciences*, *6*(4), 136. https://doi.org/10.3390/socsci6040136

Zhang, L., & Manon, J. (2000). *Gender and Achievement--Understanding Gender Differences and Similarities in Mathematics Assessment*.