THE EFFICIENCY OF PUBLIC SCHOOLS: THE CASE OF KUWAIT

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Revised May 2011

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Abstract

This paper investigates the technical, allocative and economic efficiency of public schools in Kuwait over four levels of schooling (kindergartens, primary, intermediate and secondary) and two periods (1999/00 and 2004/05) using data envelopment analysis (DEA). Mean pure technical efficiency varies between 0.695 and 0.852 across all levels of education; the majority of schools at kindergarten, primary and intermediate levels are operating at a point where returns to scale are increasing; and there are considerable cost efficiencies to be gained. In a second stage analysis of the determinants of efficiency, teacher salary and the proportion of teaching staff who are Kuwaiti are highly significant in explaining school efficiency at all levels. The former has a positive effect and the latter a negative effect. All-girls schools have significantly higher efficiency than all-boys schools. There is limited evidence that geographical location affects efficiency, and this may be a consequence of differences between regions in terms of affluence or density of population.

Key words: Middle East; Kuwait; data envelopment analysis; efficiency; schools

JEL classification: C14; C51; D24; I21; O3

Acknowledgement: The paper is based on a project that was partially funded by the Kuwait Foundation for the Advancement of Sciences (KFAS). The authors are grateful to Geraint Johnes for comments on an earlier draft.

1. INTRODUCTION

There has been little research into the education sectors of countries in the Gulf region. This is a surprising omission as the oil-rich countries of the Gulf Cooperation Council (GCC) have seen, over the last decade, a huge expansion in school age population at all levels of education (see figure 1). At secondary level, for example, school age population has risen by between 17% and 66% in the 6 Gulf states between 1999 and 2010 (compared with increases over the same period of 3% and 10% in the UK and USA respectively), and this has been accompanied by growing enrolment rates. Such rapid growth in demand for places is likely to put a considerable strain on education provision, but it is difficult to gain insights into the education systems of these countries because of the general lack of published data at school level. By studying the efficiency of education in one of the GCC countries, Kuwait, this paper aims to fill a gap in the literature and to present findings which will be of interest and relevance to education managers and policy makers in other countries in that geographical region facing similar education demands.

Kuwait is a small country that is rich in hydro-carbon resources with an estimated annual *per capita* GDP for 2010 of US$51700, and a population exceeding 2.5 million, out of which approximately 50 percent are non-nationals and just over 25% are aged less than 15 years[1]. Kuwait is therefore the richest (after Qatar) of the GCC countries and the fourth most populated (after Oman, Saudi Arabia and the United Arab Emirates). The public education system in Kuwait consists of general education (comprising two years of kindergarten, five years of primary, four years of intermediate, and three years of secondary education) and higher education (comprising college and university education). Education for the nationals is compulsory up to and including intermediate level. In the year 2008, the public education system (where education for the nationals is free of charge) accounted for approximately 66

[1] Source of data: CIA World Fact Book (https://www.cia.gov/library/publications/the-world-factbook/index.html).

percent of the total number of students enrolled in schools[2]. Whereas the public education system mainly serves the needs of the nationals, the private educational institutions, particularly schools, largely cater to the needs of the foreign population. The private schools follow different systems and include Arabic, American, British, Indian, Pakistani, French, and other schools. This paper examines only the public education system in Kuwait.

The public education system in Kuwait has grown in response to an increasing population. To meet the capital and operational needs of the system, the government invests substantial resources: in 2008, public expenditure per pupil was 10.9% of per capita GDP at primary level and 14.9% at secondary level[3]. Resources have been injected into the public education system in the belief that the greater the resources the better the outcomes. The available evidence on the relationship between resources and outcomes, however, points to a situation that is far from satisfactory. Burney *et al*. (1995, 2002) and the World Bank (2002) have shown that Kuwait's public education system suffers from production inefficiencies, the extent of which is unknown. In addition, there is a general perception that the public education system is not responsive to the educational needs of the society or the economy of the country.

To improve the performance of the system, the educational authorities have undertaken reforms that have increased the participation of the private sector, but the management of the public schools remains under government control and the school administration has limited authority over school inputs and outputs. With a rapidly growing population, the amount of resources required to meet the educational needs of the population could increase sharply and, if necessary resources are not forthcoming, there may be a detrimental impact on the quality of education. In this context, it becomes imperative for the

[2] Source of data: UNESCO Institute for Statistics Table 3b (http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=175).
[3] Source of data: UNESCO Institute for Statistics Table 19 (http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=172).

authorities to pursue cost effective measures, remove specific sources of inefficiencies, exploit economies of scale, and improve administrative, organizational, and financial management of resources. This requires the identification and quantification of inefficiencies.

The objective of this paper is to provide an in-depth analysis of the efficiency of all levels of public schools in Kuwait. It is well-known that improving education can have a beneficial effect on an economy in terms of higher productivity, lower poverty, improved income inequality, better health and economic growth (Bedi & Marshall 1999). Thus getting more from the resources spent on education in Kuwait is vital in the context of the country's development. In addition, the study of the efficiency of education in emerging and developing countries is under-researched relative to the large number of studies which have been devoted to efficiency of education in developed countries. An increased knowledge of the sources of inefficiency in education in Kuwait will therefore be useful to policy-makers in Kuwait and other emerging economies.

The analysis will take a two-stage approach: first, estimates of technical and allocative efficiency are obtained; second, possible determinants of school efficiencies are investigated. As curricula, teaching techniques, assessment methods, teachers' qualification and experience, and other requirements vary across different school levels, the analysis is conducted separately for kindergarten, primary, intermediate, and secondary schools on data for two academic years, namely 1999/00 and 2004/05. The paper is in 5 sections of which this is the first. Section 2 presents the various concepts of efficiency and the methods for their measurement. The data and models are described in section 3, while section 4 presents the results of the two-stage analysis. Conclusions and policy implications are discussed in section 5.

2. EFFICIENCY: CONCEPTUAL FRAMEWORK AND ESTIMATION

Four efficiency concepts are considered. Technical efficiency (*TE*) of a school is defined using Farrell's (1957) approach whereby a school's actual production point is compared to the point which might be achieved if it operated on the frontier. A school might not achieve 100% technical efficiency for two reasons: the first is a consequence of managerial inefficiency which means that the given output is produced by more input(s) than necessary. The second is caused by the school being the wrong size. A small school, for example, may be disadvantaged by not having sufficient pupils to be able to have subject specialist teachers. A large school, on the other hand, might have large student staff ratios which are detrimental to the learning of pupils and hence the quality of school output. The measurement of these two types of efficiency are derived from a comparison of a school's production point relative to the production frontier calculated under constant returns to scale (CRS) and under variable returns to scale (VRS), respectively. A school's scale efficiency (*SE*) is then calculated as $SE = TE_{CRS} / TE_{VRS}$ where the subscript denotes the returns to scale assumption under which technical efficiency has been calculated. The VRS technical efficiency score therefore provides a measure of *pure* technical efficiency, having taken the effect of scale out of the CRS score. Allocative efficiency (*AE*) measures the cost efficiency of the input mix used to produce a given level of output (given the input prices). It is identified by comparing the efficient production point of a school for a given output level with the least cost production point for that level of output.

All these measures of efficiency require a quantification of the mapping of inputs on to outputs. This can be achieved using either parametric or non-parametric approaches. The most common methods are stochastic frontier analysis (SFA) and data envelopment analysis (DEA). Both approaches estimate a production frontier but in the former case the frontier is parametric while in the latter case it is a non-parametric piecewise linear frontier that envelops the data. SFA assumes a distribution for the efficiencies, and the stochastic errors, and a particular functional form for the production function. Such assumptions allow statistical inferences to be drawn about the parameter estimates, and the estimates themselves can provide useful information such as input elasticities, and degree of economies of scale and economies of scope (Cohn & Rossmiller 1987). The downside is that deciding on which is the most appropriate specification is often difficult (Simmons & Alexander 1978), and the consequences of misspecification are serious: misspecification errors will be incorporated into the efficiency measure (Lovell 1993); predictions, particularly outside the valid domain, could be misleading (Hanushek 1979); parameter estimates will be biased (Simmons & Alexander 1978) and hence estimates of input elasticities and economies of scale and scope may be misleading. Further problems may arise if there is multicollinearity amongst the explanatory variables, or omission of a relevant variable (Simmons & Alexander 1978).

In DEA, misspecification problems are avoided because the technique makes no assumptions regarding the distribution of efficiencies, and, since the production function is fitted using linear programming, there are no assumptions regarding functional form (Mante 2001). Perhaps the greatest advantage of DEA is that, by enveloping the data, the DEA frontier allows each unit to be different. It therefore allows each school to have local flexibility and not to be penalised for having its own specific objectives. This may be a particularly important advantage in the context of measuring efficiency in education where each school is unique (Cohn & Rossmiller 1987). For this reason, DEA is the method of choice in the subsequent analysis. The downside is that there are no parameter estimates for the function and hence no significance tests (Geva-May 2001). In addition any errors in measurement or stochastic errors are incorporated into the measurement of efficiency.

In DEA, the technical efficiency of DMU *k* is defined as the ratio of the weighted sum of outputs to the weighted sum of inputs (Charnes *et al*, 1978; 1979):

$$TE_k = \frac{\sum_{r=1}^{s} u_r y_{rk}}{\sum_{i=1}^{m} v_i x_{ik}} \qquad (1)$$

where there are *s* outputs and *m* inputs; y_{rk} is the amount of output *r* produced by DMU *k*; x_{ik} is the amount of input *i* used by DMU *k*; u_r is the weight applied to output *r*; and v_i is the weight applied to input *i*. Input and output weights are derived by solving the following (input-oriented) linear programming (LP) equations.

$$\begin{aligned}
&\text{Minimize} \quad \theta_k \\
&\text{Subject to} \\
&y_{rk} - \sum_{j=1}^{n} \lambda_j y_{rj} \leq 0 \qquad r = 1,\ldots,s \\
&\theta_k x_{ik} - \sum_{j=1}^{n} \lambda_j x_{ij} \geq 0 \qquad i = 1,\ldots,m \\
&\lambda_j \geq 0 \qquad \forall j = 1,\ldots,n
\end{aligned} \qquad (2)$$

Thus DMU *k* is efficient if the efficiency score $TE_k = \theta_k = 1$. It should be noted that the DEA model can be easily modified to incorporate VRS by the inclusion into the above equations of the additional constraint $\sum_{j=1}^{n} \lambda_j = 1$ (Banker *et al*, 1984) and hence measures of scale efficiency can be derived.

The exposition has so far assumed that output is fixed and input quantities are variable. It may be the case that the manager has little control over some inputs (at least in the short run). The VRS model above can be modified to assume both fixed outputs and some fixed (or non-discretionary) inputs as follows (where superscript D denotes an input over which the manager has control, and ND denotes a non-discretionary input):

$$
\left.
\begin{aligned}
&\text{Minimize } \theta_k \\
&\text{Subject to} \\
&y_{rk} - \sum_{j=1}^{n} \lambda_j y_{rj} \leq 0 \qquad r = 1,\ldots,s \\
&\theta_k x_{ik}^{D} - \sum_{j=1}^{n} \lambda_j x_{ij}^{D} \geq 0 \qquad i = 1,\ldots,m \\
&x_{ik}^{ND} - \sum_{j=1}^{n} \lambda_j x_{ij}^{ND} \geq 0 \qquad i = 1,\ldots,m \\
&\sum_{j=1}^{n} \lambda_j = 1 \\
&\lambda_j \geq 0 \qquad \forall j = 1,\ldots,n
\end{aligned}
\right\} \quad (3)
$$

This model therefore allows proportional reduction in only a subset of the discretionary inputs (Banker and Morey 1986; Coelli *et al* 2005).

There has been considerable interest in the efficiency of educational institutions over the last two decades.[4] The studies differ in terms of their context, methods, orientation, country and time period. There have been relatively few parametric estimations of the production frontier, and only a minority of these studies have derived efficiency scores. Most studies are based on data for developed economies: mean efficiency scores range from around 0.708 (Grosskopf *et al* 1997) to 0.96 (Conroy & Arguea 2008) for the USA and from 0.867 to 0.974 for Finland (Mizala *et al* 2002; Kirjavainen 2007). Just one study uses parametric techniques to estimate efficiency in a developing country (Chile) where mean efficiency is estimated to be 0.9318.

Parametric production function studies provide only limited evidence regarding returns to scale. Driscoll *et al* (2003) in a study of US schools suggest that there are decreasing returns for schools located in large districts. This is confirmed by Jones *et al* (2008) who also find decreasing returns to class and school size for schools in the USA. Sengupta & Sfeir (1986), however, find that the average school in California is operating in

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[4] For detailed reviews of studies on efficiency of educational institutions, see Burney *et al*. (2009) and Worthington (2001).

an area of increasing returns to scale; greater returns to scale are experienced by those schools on the frontier than those deviating from it.

There is a far greater body of literature which has derived school efficiency estimates using a non-parametric production function approach. Only a minority of studies examine the efficiency of education in developing countries such as Chile, India and Thailand (Mizala *et al* 2002; Tyagi *et al* 2008; Kantabutra & Tang 2006). Mean technical efficiency of schools is very low in India at 0.4384 (Tyagi *et al* 2008), and is relatively low in Thailand: 0.633 to 0.691 (Kantabutra & Tang 2006). Efficiency of schools is much higher in Chile at 0.9539 (Mizala *et al* 2002). For comparison, mean efficiency of schools in developed countries generally exceeds 0.70.

3. DATA AND MODELS

In order to estimate efficiencies we need to specify the outputs and inputs of the education production function. In general, schools use capital and labour to produce teaching outputs. It is vital that the teaching outputs should be specified so as to capture the outcomes of education. Previous empirical studies have used standardized achievement or examination results, average attendance, number of graduates, number of enrolled students, retention rate, and level of earnings after leaving school. For Kuwait, standardized achievement and examination results are not available. Two possible and alternative output measures which are available are number of enrolled students (STUDENTS) and number of pupils satisfactorily completing school (GRADUATES). The latter is a more satisfactory measure of the *output* of the teaching process, but the data are not available for all school levels. The former has the advantage that it is available for all levels of schooling and all years, but its disadvantage is that it is more a measure of *input* than *output*. There is, however, a high degree of correlation between student and graduate numbers in the context of schools (since the drop-out rate is relatively low), and hence student numbers (or variables relating to enrolment) have been used to represent teaching outputs in a number of empirical studies (Lovell *et al* 1994; Ouillette and Vierstraete 2006; Jones *et al* 2008).

The list of possible input measures considered in empirical studies is large and can generally be grouped into three main categories, namely school inputs, pupil-related inputs, and environmental inputs. Data on pupil-related and environmental inputs are not available for schools in Kuwait, and so this study relies exclusively on school inputs, which include labour and capital. There are three possible input measures: number of teachers (TEACHERS), number of administrative staff (STAFF), and number of class rooms which is used as a proxy for capital input and physical resources (ROOMS). Schools are likely to have more control over adjusting levels of teachers and staff than over physical capital such as rooms (at least in the short term). Thus the variable ROOMS could be considered to be a non-discretionary input in which case the DEA model in set of equations (3) would be appropriate.

The combination of inputs and outputs used here is similar to models estimated by Bonesrønning and Rattsø (1994) and Ouellette and Vierstaete (2006). The former study uses graduates as an output and teaching time as a single input, while the latter uses full-time equivalent pupils as the output and teaching and non-teaching staff as inputs along with 3 indexes to reflect physical capital.

The data were obtained for 2 academic years (1999/00 and 2004/05) from different published and unpublished records for the entire public school population held by the Ministry of Education (MOE) in Kuwait. A very small number of schools had to be omitted from the analysis because of incomplete or inaccurate information[5]. The number of schools included at each level of education differs over time. When examining DEA results, which

[5] In the year 2004/05 (1999/00), the numbers of schools included in the samples were 170 (149) kindergarten schools, 203 (182) primary schools, 156 (163) intermediate schools, and 114 (117) secondary schools in Kuwait. The number of omitted schools was just 1 at intermediate level (in both time periods) and 1 at secondary level (1999/00 only).

reflect efficiency relative to those in the sample, some caution is therefore required when making comparisons over time periods. Descriptive statistics of all inputs and outputs are reported in Table 1. Not surprisingly, kindergartens are typically much smaller (in terms of pupil numbers) than all other school types. The typical kindergarten has around 250 to 300 pupils, 20 staff and almost 10 classrooms. Typical schools at primary, intermediate and secondary levels have approximately 530 to 650 pupils. It should be noted that the average secondary school has considerably more teachers (over 75) than primary and intermediate schools.[6]

[Table 1 here]

4. ESTIMATES OF EFFICIENCY

Data on the number of pupils successfully completing school (GRADUATES) were available for only primary and intermediate schooling levels (in both years of the study), while data on administrative staff (STAFF) were not available for any level of schooling in 1999/00, or for secondary schools in 2004/05. Table 2 describes the various models which have been estimated for each level of schooling and each time period. DEA efficiencies are summarized in Table 3 for model 3 only since this is the only model which can be estimated consistently over the four levels of schooling and the two time periods. CRS and VRS DEA efficiencies are derived using an input-oriented approach[7] and allocative efficiencies are computed under the assumption of VRS[8]. The VRS efficiency scores derived on the

[6] The average number of teachers varies over time for primary and intermediate schools, and this is another reason for taking care when making inter-temporal comparisons of the results.

[7] While the managers (or principals) of public schools in Kuwait have little control over the output or the inputs, ultimately, the central educational authorities control the level of inputs within the system, and hence an input-oriented approach is used. It should be noted that the results vary little according to orientation (and CRS efficiency estimates are identical regardless of orientation).

[8] To estimate allocative efficiency, average annual salary was used as price of teachers and staff (where appropriate). In the case of class rooms, the price was assumed to be constant across schools.

assumption that the variable ROOMS is a non-discretionary input are also computed for comparison[9].

[Table 2 here]

[Table 3 here]

The alternative models were estimated where data were available in order to perform a sensitivity analysis, the results of which are presented in Table 4. The inclusion of administrative staff (STAFF) as an additional input has no significant effect on school ranking based on efficiency score. Similarly, the definition of output (GRADUATES or STUDENTS) has no significant effect on school ranking based on efficiency score (see table 4a). This supports the use of model 3. In addition, the comparison of the VRS models where the variable ROOMS is considered, respectively, as a discretionary and non-discretionary input, suggests no significant effect on school ranking (see table 4b). Thus the results of the models where all inputs are flexible are interpreted in the sequel.

[Tables 4a and 4b here]

Mean pure technical efficiency of schools in Kuwait (derived through application of a VRS DEA) varies from 0.700 to 0.852 in 2004/05 and from 0.695 to 0.831 in 1999/00. This is higher than school efficiency in India and Thailand but lower than that in Chile (although it should be remembered that efficiency is calculated relative to the country's own frontier and hence such comparisons with other countries are not particularly valid). The results suggest that schools in Kuwait use more inputs than necessary (between 15% and 30% more) for the pupils enrolled. There is also tentative evidence that kindergartens have more widely dispersed efficiency scores while primary schools have the least widely dispersed efficiencies.

The results for scale efficiency indicate that schools in Kuwait are typically not operating at their optimum scale size. Indeed the vast majority of schools at kindergarten, primary and intermediate levels are operating at increasing returns to scale suggesting that

[9] The VRS non-discretionary efficiency scores are calculated using the software package PIM; the remaining efficiencies have been estimated using the software package Limdep.

there are gains to be made from operating at a larger size[10]. It should be noted that this study takes no account of additional costs, such as travel-to-school costs, which may be affected by concentrating education in larger sized establishments. Thus, although there are apparent gains to be made by increasing the output to input ratio of schools at all levels, all potential increased costs of such a policy should be thoroughly investigated.

While the estimates of efficiency provide an overview of the relative performance of public schools, it can also be useful to examine whether there are any characteristics of the school which affect the efficiency with which schools convert inputs into outputs. To determine the relationship between school characteristics and technical efficiency, the estimates of technical efficiency obtained using model 3 and assuming VRS are regressed upon a number of explanatory variables. For each level of schooling, two explanatory models are estimated: one where all input variables are assumed to be discretionary; one whene the variable ROOMS is considered to be non-discretionary. Data limitations constrain the analysis to four possible factors: the geographical location of school[11], the proportion of teaching staff who are Kuwaiti nationals (KUWAIT), the average annual salary level of the teaching staff (SALARY), and whether the school is an all boys school (BOYS).[12] The size of the school is not investigated as a possible determinant of efficiency as the dependent variable is the VRS efficiency and thus size has already been taken into account in calculating the efficiency score.

[10] The DEA results for 2004/05 indicate that over 99% of kindergartens, 95% of primary schools, 98% of intermediate schools and 47% of secondary schools are operating in a situation of increasing returns to scale.

[11] The public education system in Kuwait is administrated by the Ministry of Education, and is currently divided into six educational districts, which are Al-Aasimah, Al-Ahmedi, Farwaniya, Hawally, Al-Jahra, and Mubarak Al-Kabir. In 1999/00, there were only five educational districts (since Mubarak Al-Kabir was grouped with Hawally). To take account of the geographical location, four dummy variables have been included in the regression (AL-AASIMAH, AL-AHMEDI, FARWANIYA and HAWALLY/MUBARAK). Al-Jahra is therefore the base region.

[12] An important feature of Kuwait's public education system is that beyond the kindergarten level (where no schools are segregated) the schools are all segregated. Thus, the last variable is only applicable to primary, intermediate and secondary education levels.

The geographical location of a school might affect its efficiency for a number of reasons. Funding might vary by educational district and the geographical dummies would pick up such an effect. The regions themselves vary in terms of size, population and density of population: Al-Aasimah, Hawally and Mubarak and Farwaniya are all small in area but have relatively large populations. Al-Ahmedi and Al-Jahra are much larger but more sparsely populated. Thus the regional dummies may capture any rural-urban effect on efficiency. The quality of teaching staff would be expected to have a positive effect on efficiency. Average teacher salary is assumed to reflect quality of staff and should therefore have a positive effect on efficiency. Evidence from previous empirical studies is mixed: Bradley *et al* (2001) find evidence of a significant positive effect of teacher salary on efficiency in English secondary schools while Ruggiero and Vitaliano (1999) find the opposite result in New York school districts; Rassoulli-Currier (2007) find no significant relationship between teacher salary and efficiency in Oklahoma schools. The proportion of teachers with Kuwaiti nationality has also been included in the analysis because there has been a shift from foreign (experienced but relatively low-paid teachers) to Kuwaiti national (less experienced and more highly-paid) teachers. The variable SALARY may not therefore be a perfect reflection of teacher experience and so KUWAIT is included as well. Finally, evidence from other countries suggests that all-boys schools perform less well than all-girls schools (Bradley *et al* 2001). Thus the variable BOYS is included to explore this in the context of Kuwaiti education where segregated education is the norm (except in kindergartens). Descriptive statistics for the variables included in the second stage analysis are displayed in Table 5.

[Table 5 here]

The performance of a second stage analysis of DEA efficiencies using a Tobit regression model is standard practice (examples in the schools context include: McCarty and Yaisawarng 1993; Ruggiero *et al* 1995; Kirjavainen and Loikkenen 1998; Ruggiero and

Vitaliano 1999; Bradley *et al* 2001; Chakraborty *et al* 2001; Kantabutra and Tang 2006; Borge and Naper 2006; Rassouli-Currier 2007) and is based on the premise that the dependent variable comprising DEA efficiency scores is a censored variable. In fact, recent literature argues that efficiency scores are not censored but are fractional data (McDonald 2009), thus making Tobit analysis inappropriate. Evidence from a comparison of various possible second stage approaches (Hoff 2007; McDonald 2009) suggests that ordinary least squares regression analysis (with White heteroscedastic-consistent standard errors) is the best second stage approach in terms of producing consistent estimators and valid (large sample) hypothesis tests which are robust to heteroscedasticity and the distribution of disturbances. This is therefore the method of choice in the ensuing analysis.

Table 6 shows the models for the four educational levels (kindergarten, primary, intermediate, and secondary). The results are broadly similar irrespective of which efficiency scores are used as the dependent variable, and so the results are reported and interpreted in detail only for the case where all inputs are considered discretionary. While all models are significant (in terms of the F statistic), the models for kindergartens have the highest explanatory power. Efficiencies of primary and intermediate schools in 2005/05 are least successfully explained by the explanatory variables included in the model.

[Table 6 here]

Geographical location appears to have a limited effect on efficiency: kindergartens and primary schools in the Al-Aasimah region are more efficient in 2004/05 compared to those in other regions. Many of the schools in the Al-Aasimah region are relatively old and are located in comparatively affluent areas. In addition, kindergartens in Al-Ahmedi are more efficient than those in other regions. This is true of both years of the study. In contrast to Al-Aasimah, Al-Ahmedi is a large region with a relatively low population.

The coefficient with respect to teacher salary is positive and statistically significant at the 5% significance level for all school levels and periods, with the exception of intermediate and secondary schools in 1999/00. This result is in line with Bradley *et al* (2001) but contrary to Ruggiero and Vitaliano (1999). The evidence implies that higher teacher salary tends to improve the technical efficiency of schools in Kuwait. The higher magnitude of the coefficient on SALARY for kindergartens compared to other school levels is initially puzzling, as one might expect experience to have a greater effect on efficiency at high (rather than low) school levels. The result is possibly a consequence of correlation: it should be clear from previous discussion that schools with a high proportion of teachers who are Kuwaiti nationals are likely to have higher average salaries, and so KUWAIT and SALARY are likely to be correlated. However, since the proportion of Kuwaiti teachers is lower in higher level schools (and hence the proportion of expatriate teachers is higher in these schools) compared to kindergartens (see Table 5), SALARY is a more inadequate reflection of experience in the higher level schools. Moreover, the correlation between SALARY and KUWAIT is much stronger as level of school rises; indeed there is no significant correlation between the two at kindergarten level. The difference (across school levels) in the magnitude of the coefficient on SALARY is therefore likely to be a consequence of the varying relationship between SALARY and KUWAIT.

The proportion of Kuwaiti teachers has a significant negative effect on efficiency for all levels of schooling except intermediate (where the coefficient is negative but not significant) and for both years except in the case of primary schools in 2004/05. The precise effect of KUWAIT (like that of SALARY) is blurred by the multicollinearity between SALARY and KUWAIT. The two results, however, suggest that teacher experience and qualifications are important in determining efficiency and hence schools should develop a policy of recruiting more qualified and experienced teachers in order to improve school efficiency.

Finally, the coefficient with respect to dummy for gender is negative for all levels, but statistically significant only for primary (in 1999/00) and secondary levels. This implies that the efficiency of all-girls schools is higher compared to all-boys schools. The policy implications are unclear in the absence of evidence regarding why this is the case. If the all-girls schools are traditionally managed differently from the all-boys schools, then the latter should amend their managerial practice in order to improve efficiency. It is more likely, however, that girls have characteristics which allow them to respond better to current teaching methods used in Kuwait, and hence their schools achieve greater efficiency. If this is the case, alternative methods of teaching which appeal more to the characteristics of boys need to be investigated to improve efficiency in all-boys schools.

5. CONCLUSIONS

This paper has investigated the technical, allocative and economic efficiency of public schools in Kuwait over four levels of schooling (kindergartens, primary, intermediate and secondary) and two periods (1999/00 and 2004/05) using DEA. Average pure technical efficiency varies between 0.695 and 0.852 over the two years and across all levels of education. These are comparable to non-parametric estimates of school efficiency found for schools in Thailand and Chile, but somewhat higher than those for schools in India (Kantabutra and Tang 2006; Mizala *et al.* 2002; Tyagi *et al* 2008). The results suggest that Kuwaiti schools, at all levels, could, by improving managerial practices, produce the same output with fewer inputs. In addition, returns to scale for all levels of schools are generally increasing suggesting that schools could be more efficient by expanding their size. A degree of caution is necessary in developing policy from this result, however, since possible costs of amalgamating schools to increase unit size are not considered. Such costs include increased travel costs for pupils and possible detrimental effects of more time spent travelling on pupil achievement. These have not been taken into account and should be thoroughly investigated before adopting such a policy. Additional results indicate that there are also considerable cost efficiencies to be gained in public schools in Kuwait: average allocative efficiency ranges from 0.606 for secondary schools to 0.975 for secondary schools.

The most emphatic result of a second stage analysis of the determinants of pure technical efficiency was the significant and positive impact of average teacher salary on efficiency. To the extent that SALARY reflects teacher experience and qualifications, this result emphasizes the need for more qualified and experienced teachers in public schools to increase efficiency. A related result is that the coefficient on proportion of teachers who are Kuwaiti nationals was negative and statistically significant for all school levels. Authorities in Kuwait have recently pursued a policy of replacing expatriate teachers with nationals and it is likely that in the process more experienced and qualified teachers are being replaced by relatively young, inexperienced and less qualified teachers. The result is therefore likely to be confirmation of the importance of teacher experience and qualifications on efficiency. Further investigation into why this result occurs (possibly using a case study approach) should be undertaken. It is possible that additional training and support for the new teachers should be provided in an effort to improve teachers and school efficiency.

An additional finding of the second stage analysis is that the technical efficiency of all-girls schools is higher than that of all-boys schools. Perhaps there is something in the way that the all-girls schools are managed that should be looked into and used to improve efficiency of all-boys schools. Alternatively, teaching methods in all-boys schools might need to be developed to inspire learning amongst male pupils.

There is limited evidence that efficiency might be higher in the relatively affluent region of Al-Aasimah, but this was not conclusive and requires further investigation with additional years of data. Kindergartens appear to be more efficient in Al-Ahmedi (which is a large region with relatively low population) than in other regions, but why this is the case requires analysis which is beyond the scope of this paper.

In the context of a growing population and increasing resources devoted to public education in Kuwait, this paper has estimated the level of efficiency from kindergarten through to secondary school level and has achieved a greater understanding of the determinants of efficiency in different types of schools. Moreover, improvements in the education sector which could be achieved through increased efficiency could have beneficial effects on the economy itself.

Various sensitivity analyses conducted here suggest that estimates of efficiency presented in this paper are not particularly sensitive to changes in the definition of output, to the inclusion of an additional input, or to the treatment of capital input as non-discretionary. It has become apparent from conducting this study, however, that much more could be learnt about efficiency and its determinants in Kuwaiti schools if there were a better system of data collection and record. More information on pupil achievement (possibly split by broad subject) and on capital inputs would provide a better base from which to estimate efficiency; data regarding pupil and environmental characteristics could add insights into the second stage analysis of efficiency.

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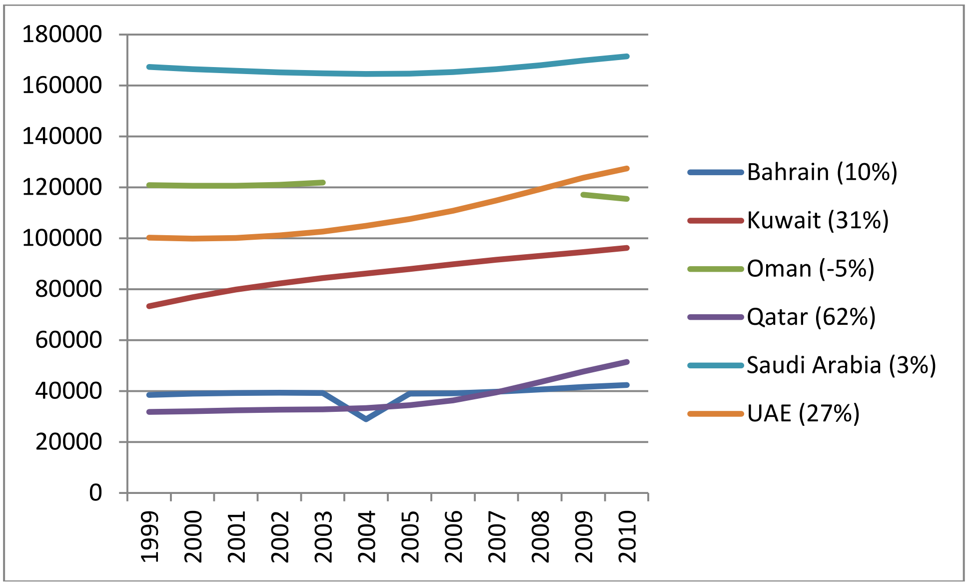
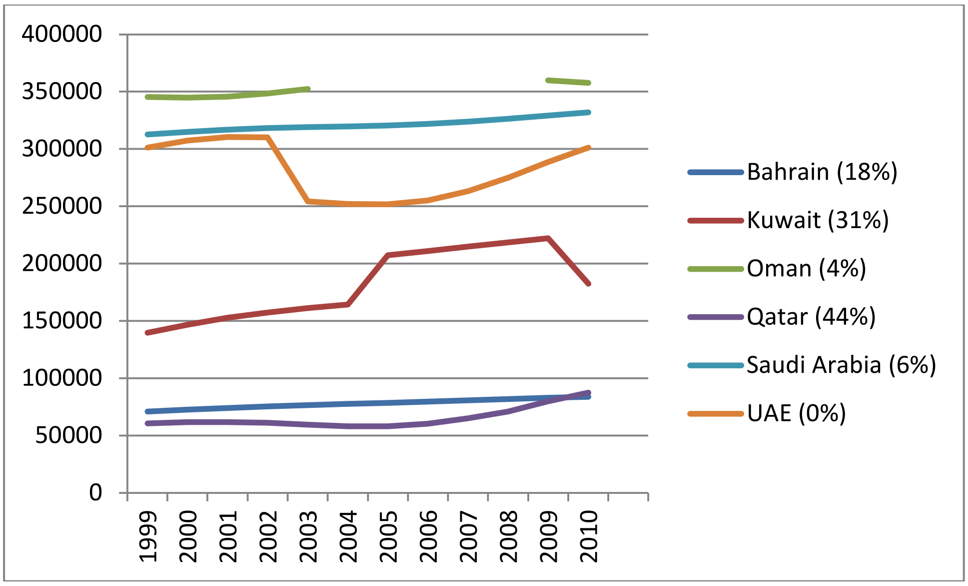
Figure 1: School age population by education level in the 6 GCC countries, 1999 to 2010

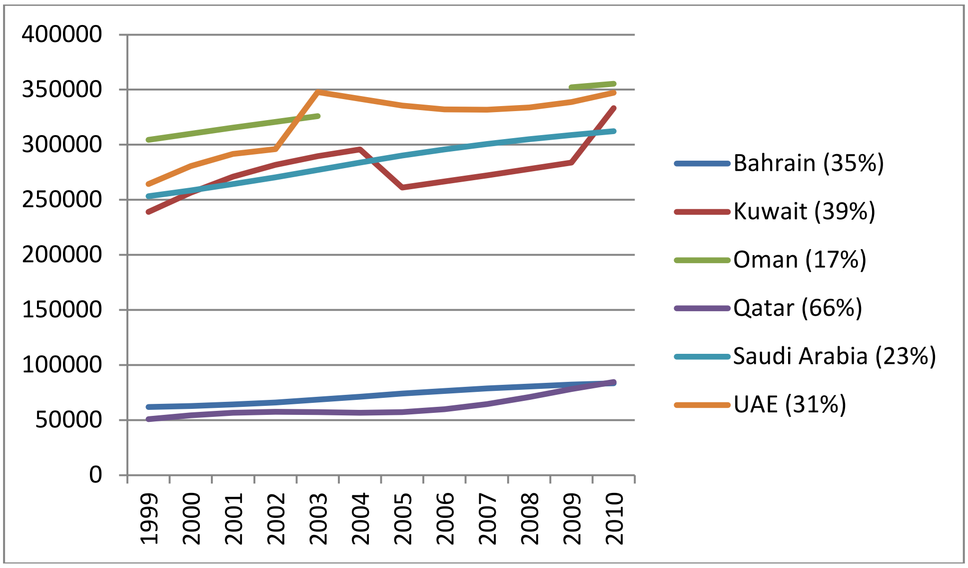
a) **Pre-primary**



b) **Primary**



c) Secondary



Notes:

1. Data for Oman are not available for 2004 to 2008 inclusive.
2. Data for Saudi Arabia have been scaled by 10.
3. Numbers in parentheses are the increase from 1999 to 2010.

Source of data: UNESCO Institute for Statistics, http://stats.uis.unesco.org/unesco/TableViewer/tableView.aspx?ReportId=173

Table 1 Descriptive statistics

	2004/05					1999/00				
a) Kindergarten	**Min**	**Max**	**Mean**	**SD**	**n**	**Min**	**Max**	**Mean**	**SD**	**n**
STUDENTS	66	644	240.57	116.60	170	25	689	296.32	120.02	149
GRADUATES										
TEACHERS	9	41	22.55	6.84	170	6	32	20.21	5.20	149
STAFF	9	25	16.52	3.20	170					
ROOMS	4	15	9.12	2.47	170	2	15	9.83	2.50	149
b) Primary										
STUDENTS	66	1163	651.03	206.33	203	75	1079	530.26	177.87	182
GRADUATES	66	1130	626.09	200.50	203					
TEACHERS	8	130	66.40	18.94	203	6	75	42.95	10.54	182
STAFF	1	35	20.00	5.39	203					
ROOMS	5	44	25.38	7.28	203	4	33	17.90	5.10	182
c) Intermediate										
STUDENTS	58	1311	621.78	220.18	156	74	1343	578.01	239.63	163
GRADUATES	47	1199	573.92	206.96	156	56	1223	513.38	215.16	163
TEACHERS	13	109	62.55	17.82	156	13	107	53.42	16.80	163
STAFF	2	35	18.37	5.28	156					
ROOMS	4	39	21.07	6.51	156	4	38	18.62	7.03	163
d) Secondary										
STUDENTS	17	1098	539.48	215.34	114	45	1535	631.06	304.12	117
GRADUATES										
TEACHERS	25	184	79.85	25.60	114	16	135	75.15	28.76	117
STAFF										
ROOMS	3	40	22.29	7.65	114	4	46	21.68	8.09	117

Table 2: Possible models of school production

Model	Output	Inputs	Data Available for Level
Model 1	STUDENTS	TEACHERS, STAFF, ROOMS	Kindergarten in 04/05 only Primary in 04/05 only Intermediate in 04/05 only
Model 2	GRADUATES	TEACHERS, STAFF, ROOMS	Primary in 04/05 only Intermediate in 04/05 only
Model 3	STUDENTS	TEACHERS, ROOMS	Kindergarten in 04/05 and 99/00 Primary in 04/05 and 99/00 Intermediate in 04/05 and 99/00 Secondary in 04/05 and 99/00
Model 4	GRADUATES	TEACHERS, ROOMS	Primary in 04/05 and 99/00 Intermediate in 04/05 and 99/00

Table 3. Estimates of school efficiency (arithmetic mean) by level of school using model 3

	Overall TE CRS	Pure TE VRS	SE	AE[1]	VRS Non-discretionary input model	n
2004/05						
Kindergarten	0.499	0.700	0.714	0.917	0.648	170
Primary	0.794	0.852	0.934	0.860	0.834	203
Intermediate	0.794	0.840	0.946	0.838	0.816	156
Secondary	0.729	0.778	0.934	0.606	0.656	114
1999/00						
Kindergarten	0.621	0.712	0.870	0.949	0.683	149
Primary	0.801	0.831	0.964	0.844	0.819	182
Intermediate	0.590	0.695	0.861	0.924	0.628	163
Secondary	0.718	0.794	0.902	0.975	0.542	117

Notes:
1. AE is derived from VRS DEAs. Average annual salary was used as price of teachers and staff (where appropriate); the price of class rooms was assumed to be constant across schools
2. In this case, the specification of the production function produced residuals with the wrong skew. Thus λ was not significantly different from zero. The OLS parameter estimates are therefore also the SFA parameter estimates of the production function, and hence there are no significant inefficiencies. In such a situation, an alternative specification which provides efficiencies should be sought, but the options with the small number of inputs and outputs used here are limited.

Table 4 Sensitivity analysis of the results:

a) **Spearman's rank correlation coefficients between models 1 to 4**

	2004/05	1999/00	2004/05	2004/05
	Students vs. Graduates: Model 3 vs. Model 4	Students vs. Graduates: Model 3 vs. Model 4	Students vs. Graduates: Model 1 vs. Model 2	Number of Inputs: Model 1 vs. Model 3
Kindergarten				
Overall Technical Efficiency (CRS)				0.937
Pure Technical Efficiency (VRS)				0.774
Scale Efficiency (SE)				0.989
Allocative Efficiency (AE)				0.661
Number of Observations				170
Primary				
Overall Technical Efficiency (CRS)	0.883	0.930	0.912	0.942
Pure Technical Efficiency (VRS)	0.899	0.933	0.913	0.979
Scale Efficiency (SE)	0.898	0.824	0.926	0.915
Allocative Efficiency (AE)	0.979	0.984	0.981	0.936
Number of Observations	203	182	203	203
Intermediate				
Overall Technical Efficiency (CRS)	0.897	0.489	0.898	0.966
Pure Technical Efficiency (VRS)	0.916	0.629	0.910	0.966
Scale Efficiency (SE)	0.848	0.398	0.886	0.974
Allocative Efficiency (AE)	0.993	0.854	0.982	0.902
Number of Observations	156	163	156	156

Note: No sensitivity analysis was possible at the secondary school level because of data constraints.

b) Spearman's rank correlation coefficients between VRS models with and without non-discretionary inputs

	2004/05	1999/00
Kindergarten		
Model 1	0.919	-
Model 3	0.904	0.896
Primary		
Model 1	0.936	-
Model 2	0.983	-
Model 3	0.878	0.963
Model 4	0.950	0.937
Intermediate		
Model 1	0.977	-
Model 2	0.970	-
Model 3	0.969	0.781
Model 4	0.959	0.889
Secondary		
Model 3	0.980	0.713

Table 5 Descriptive statistics for the variables included in the Tobit analysis

	2004/05					1999/00				
a) Kindergarten	**Min**	**Max**	**Mean**	**SD**	**n**	**Min**	**Max**	**Mean**	**SD**	**n**
AL-AASIMAH	0	1	0.182	0.387	170	0	1	0.195	0.397	149
HAWALLY/ MUBARAK	0	1	0.353	0.479	170	0	1	0.349	0.478	149
FARWANIYA	0	1	0.171	0.377	170	0	1	0.168	0.375	149
AL-AHMEDI	0	1	0.194	0.397	170	0	1	0.174	0.381	149
SALARY	0.359	2.394	1.202	0.400	170	0.708	1.706	1.214	0.140	149
KUWAIT	0.765	1	0.949	0.765	170	0.800	1	0.952	0.032	149
b) Primary										
AL-AASIMAH	0	1	0.187	0.391		0	1	0.214	0.411	182
HAWALLY/ MUBARAK	0	1	0.266	0.443		0	1	0.242	0.429	182
FARWANIYA	0	1	0.167	0.374	203	0	1	0.165	0.372	182
AL-AHMEDI	0	1	0.232	0.423	203	0	1	0.214	0.411	182
SALARY	0.375	1.406	0.829	0.238	203	0.620	1.995	1.172	0.199	182
KUWAIT	0.220	0.960	0.723	0.144	203	0	1	0.894	0.110	182
BOYS	0	1	0.498	0.501	203	0	1	0.500	0.501	182
c) Intermediate										
AL-AASIMAH	0	1	0.256	0.438	156	0	1	0.209	0.408	163
HAWALLY/ MUBARAK	0	1	0.192	0.395	156	0	1	0.239	0.428	163
FARWANIYA	0	1	0.173	0.380	156	0	1	0.172	0.378	163
AL-AHMEDI	0	1	0.231	0.423	156	0	1	0.209	0.408	163
SALARY	0.406	1.837	1.081	0.402	156	0.467	1.725	0.954	0.157	163
KUWAIT	0.150	0.957	0.600	0.248	156	0	1	0.579	0.304	163
BOYS	0	1	0.481	0.501	156	0	1	0.472	0.501	163
d) Secondary										
AL-AASIMAH	0	1	0.211	0.409	114	0	1	0.197	0.399	117
HAWALLY/ MUBARAK	0	1	0.272	0.447	114	0	1	0.282	0.452	117
FARWANIYA	0	1	0.167	0.374	114	0	1	0.261	0.370	117
AL-AHMEDI	0	1	0.237	0.427	114	0	1	0.239	0.429	117
SALARY	0.085	2.749	0.991	0.477	114	0.216	1.491	0.803	0.192	117
KUWAIT	0.072	0.867	0.460	0.244	114	0.034	0.875	0.426	0.252	117
BOYS	0	1	0.491	0.502	114	0	1	0.504	0.502	117

Table 6 Second Stage Regression Results: Dependent variable is input-oriented VRS efficiency calculated on the assumption that all inputs are flexible

	Kindergarten		Primary		Intermediate		Secondary	
Variable	1999/00	2004/05	1999/00	2004/05	1999/00	2004/05	1999/00	2004/05
INTERCEPT	1.107**	1.199**	0.838**	0.806**	0.857**	0.778**	0.970**	1.047**
	(2.805)	(6.817)	(13.871)	(16.635)	(6.722)	(27.986)	(12.707)	(12.129)
AL-AASIMAH	-0.040	0.155**	-0.022	0.043**	-0.025	0.045	-0.000	0.013
	(1.893)	(4.473)	(1.447)	(3.174)	(0.673)	(1.911)	(0.013)	(0.276)
HAWALLY/	-0.032	0.027	0.029**	-0.016	0.046	-0.017	0.037	-0.047
MUBARAK	(1.584)	(1.022)	(2.024)	(1.434)	(1.236)	(1.204)	(1.276)	(1.541)
AL-FARWANIYA	-0.000	-0.013	0.033**	-0.023	-0.021	-0.011	-0.032	-0.024
	(0.008)	(0.421)	(2.275)	(1.694)	(0.583)	(0.540)	(1.011)	(0.662)
AL-AHMEDI	0.052**	0.062**	0.039**	-0.013	-0.055	-0.039	-0.043	-0.020
	(2.140)	(2.007)	(2.594)	(1.079)	(1.711)	(1.974)	(1.509)	(0.623)
SALARY	0.459**	0.200**	0.128**	0.088**	-0.026	0.098**	0.129	0.142**
	(5.860)	(5.594)	(3.880)	(3.305)	(0.241)	(2.539)	(1.781)	(2.775)
KUWAIT	-0.990**	-0.829**	-0.181**	-0.025	-0.217	-0.066	-0.468**	-0.628**
	(2.876)	(4.391)	(3.667)	(0.428)	(1.533)	(1.034)	(4.207)	(5.982)
BOYS			-0.024**	-0.012	-0.005	-0.002	-0.149**	-0.208**
			(2.328)	(0.920)	(0.062)	(0.130)	(2.925)	(3.663)
N	149	170	182	203	163	156	117	114
F-statistic	26.16	13.66	10.67	3.10	8.25	3.39	5.11	5.36
(probaility)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)

Notes: Figures within the parentheses are t-statistics (based on White adjusted standard errors). ** = significant at the 5% significance level.