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PERFORMANCE IN PRIMARY SCHOOLS: A NONPARAMETRIC APPROACH*

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BACKGROUND

In common with other developed countries, the UK experienced a large drop in the number of births during the late 1960s and the 1970s. This, at first, was seen as an opportunity to save money. Local Education Authorities (LEAs), the bodies responsible for school education, were encouraged to close schools in order to reduce surplus capacity. A change of government in 1979 changed the emphasis of the school closures programme. The Rate Support Grant, the money that Central Government makes available to support the activities of Local Government, was made to depend, for the first time, on the number of children in each LEA. Thus, as the number of children fell, so did the finance available to Local Councils. The determinants of the fall in births have been studied by Werner[1], and the social consequences of school closures by Mar Molinero[2].

The availability of spare places made it possible to develop a policy of encouraging parental choice of schools. Schools were required to publish certain information to help parents with their choice. Parents were expected to choose the "best" schools for their children and, in doing so, bad schools would decline and be eventually closed. Changes were also made to the way in which the schools are managed. Every school in the UK has a governing body which responds for its good management. Changes were initially made to the composition of the governing bodies in order, it was hoped, to improve their managerial expertise. For example, each governing body was to have a representative of the local business community (Education Regulations 1989).

The 1986 Education Reform Act brought two major changes with tradition. The first one is concerned with the content of the curriculum, the second with the way in which schools are financed.

Consider finance first, LEAs used to employ and pay staff, the main component of school cost. There was no formal way in which this was done. School budgets reflected historical funding decisions. Once a member of staff had been appointed, finance was made available to the school to pay for his/her salary. If the number of children declined, and

staff was no longer required at a given school, the redundant persons could be "redeployed" to a different school. The Education Reform Act 1986 changed all this by introducing Local Management of Schools (LMS). Each LEA was required to develop a formula to be used to fund schools. The budget available to each school was subsequently based on the number of children, their ages, a supplement for special education needs, and a contribution to overheads. Governing bodies became responsible for expenditure decisions, including employing and dismissing staff, and for the quality of the curriculum.

The other major change relates to the curriculum. In the past, each LEA had a policy on what was to be taught in each school and what subjects would take priority in each school. All this changed with the introduction of the National Curriculum . National guidelines were issued on what each child was expected to know at several landmark ages. Standardised Assessment Tests (SATs) were introduced to assess the extent to which each school had been successful in the achievement of the targets. This information, the so-called "league tables", is published in the press and also in the Internet.

In line with the above changes, a national inspection system, OFSTED, was introduced (1992 Education Act). Each school is inspected about once every four years by a team of OFSTED inspectors. The inspectors comment on all aspects of school life, including the quality of teaching, the quality of management, and the progress that is made by children. OFSTED publishes its reports and makes them available through the Internet.

The pressure exerted by Central Government on LEAs so that they reduce the number of spare places has not declined with time, nor with the change in the political orientation of Central Government which took place in 1997. OFSTED started to inspect LEAs in 1997. An OFSTED and Audit Commission[3] report on Manchester LEA which comments on its failure to sufficiently reduce the number of spare school places is a good example of this continuing pressure.

The change of government brought with it a new emphasis on academic results. Schools are to improve their performance in numeracy and literacy. Schools, and LEAs are

required to set improvement targets, and are to be assessed on their ability to meet these targets[4]. Setting targets for improvement requires an assessment, on the basis of available information, of whether a school is achieving the best it can from its pupils. There is currently no lack of data on individual local schools, but it is, however, notoriously difficult to interpret. How can we assess, in the light of available information, if a school is efficient in the use of its resources, and in achieving good results? How can we establish if a school is well managed? What is the impact on results, if any, of school size, good teaching, special education children, discipline, ethos, and class size? What variables should be taken into account when looking a particular school? Up to what point a quantitative school assessment based on published information differs from the overall assessment made by OFSTED inspectors? Up to what point do parents perceive the quality of a school in the same way as OFSTED?

These issues are of relevance not only to parents but to LEAs and even to Central Government. To address them, a study was made of a set of three homogeneous LEAs: Hampshire, Southampton and Porstmouth. The study concentrates on Key Stage 2, the result of the SAT taken at the age of 11. This paper is organised as follows. First, policy issues are illustrated by making reference to debates that took place in the Education Committee of Southampton LEA. Some important issues of principle emerged from such debates. Officers presented reasoned recommendations based on their interpretation of available information. The data set is described next together with some Initial Data Analysis. The issue of efficiency in the use of resources is explored by means of Data Envelopment Analysis (DEA). A DEA model selection procedure based on the comparison between reduced and extended formulations is used to select a parsimonious model. Measures of efficiency are next included in a regression model. The paper ends with some reflections for policy implementation.

LOCAL ISSUES IN THE MANAGEMENT OF EDUCATION

Southampton and Porstmouth became independent LEAs on the 1st April 1997. Prior to that date they had been part of the much larger Hampshire LEA. A year after acquiring

unitary status, management procedures had changed little in Southampton. The same schools were managed in the same way, using the same formula as before.

Inevitably, one of the first actions of the new Southampton LEA was to review existing provision. The District Auditor produced a report, never made public, in which it suggested that there was surplus capacity in the primary school sector, and that the situation would get worse with time. The District Auditor pointed out that there were revenue costs of keeping these spare places and that the City of Southampton should take action in order to reduce the number of places, so that value for money could be achieved.

The LEA produced a set of "policy principles" based, it was claimed, on the recommendations of the District Auditor. It was stated that small primary schools were at a disadvantage, and that no school should have an intake of less than two classes (about 60 children) unless the school contained all age groups, from 4 to 12, in which case an intake of 30 children per year could be considered to be appropriate[5].

Later on, during the consultations to amalgamate two primary schools, an infant and a junior school, the Director of Education Planning issued a report in which he stated that "there should be a higher proportion of all through primary schools in the city in line with the evidence base for the educational benefits this offers"[6]. No details were given about what the benefits were or what evidence there was to support this view.

Besides school size and continuity of education, other matters were identified by the LEA as affecting the quality of education provided in Southampton schools. The Chief Inspector for Southampton schools, an employee of the LEA, produced a report on standards and quality in Southampton schools based on OFSTED inspection reports, test results at Key Stages 1 and 2, and information collected during visits to schools. A series of themes emerged from this report. The Chief Inspector observed that, in general, in primary schools, girls did better than boys in all subjects. Commenting on school discipline, it was suggested that "there are clear linkages in some Southampton classrooms between poor behaviour and dull and uninspiring lessons or weak discipline". This suggest a link

between disciplinary measures, such as exclusions, and quality of teaching. On the subject of religious education, it was observed that this made a contribution to the pupil's moral development, but the Inspector declined to comment on how this found a reflection on the curriculum. The inspector was more forthcoming on the subject of parental involvement which, it was said, was crucial in the drive to raise standards. Finally, the quality of management was said to "have a significant impact on the standards pupils achieve"[7]. There was no mention of what formal analysis, if any, had been made in order to arrive at these conclusions.

The lack of any supporting evidence for what are important issues in the management of education is worrying. Decisions made by the LEA affect the welfare of may individuals. Substantial amounts of money are involved. A cynical view would be that decisions are made on political (or other) grounds, and that data analysis only serves to confuse the issue. Nevertheless, it is reasonable to suspect, along with the Chief Inspector, that sex mix, discipline, quality of teaching, moral development, parental involvement, and quality of management may contribute to the standards achieved in primary schools. However, we take this as a hypothesis to be tested rather than as self-evident facts.

The new Central Government made the raising of standards a national priority[8], and so did Southampton LEA at the local level. Targets were set on numeracy and literacy for Southampton schools[9]. Standards were defined, both by Central and Local Government, as the percentage of children who achieved level 4 or better in SAT results. Again, it was not disclosed how these targets had been set. It is possible to argue that raising standards can be seen from two different perspectives: achieving what is being done elsewhere, and exceeding it. Schools could be directed to achieve what has been demonstrated by other schools, operating under similar conditions, could be achieved. We can refer to this as "removing inefficiency". Once inefficiency has been removed, any increase in results is a genuine improvement. Can inefficiency in schools be assessed on the basis of published information? If this is the case, targets can be set for each school to achieve at least what has been demonstrated can be achieved.

In this paper we are concerned with identifying inefficiency in the achievement of academic results, in line with Central and Local priorities. We are aware of the fact that a school is more than a production facility whose aim is to produce the best possible academic results but we will not enter into that debate in this paper. The technique used to assess the academic efficiency of a school is Data Envelopment Analysis. The following section describes the data used in this paper.

DATA

Information on Hampshire, Southampton, and Porstmouth schools was obtained from the OFSTED database using a remote link. Data produced by OFSTED takes two different forms: factual information, and value judgements. The usual caveats to the interpretation of aggregate data apply in this case, but value judgements expressed by OFSTED are particularly controversial[10]. Nevertheless, the OFSTED database remains the most comprehensive source of data despite its limitations.

The data spans the years 1994, 95, 96, 97 and 98. As it has already been mentioned, during most of the period analysed Southampton and Porstmouth were part of Hampshire. Only during the academic year 1997/98 they achieved independent status, but they continued to operate virtually the same funding arrangements, they had similar policies on children with Special Education Needs, and management styles remained largely unchanged. Thus, we can claim uniformity in the selection of our data, as it is required by DEA[11].

The OFSTED database was invaluable to obtain statistical information which is not otherwise published. SAT 2 results, roll, class sizes, number of exclusions (temporary and permanent), number of children with special education needs, proportion of females, proportion of children who qualify for free school meals, and percentage of parents who respond to the OFSTED survey, were all obtained from this database. This information should not be controversial, as it summarises statistical data. Schools have an opportunity to comment on the data and correct any factual errors, so we expect the information on

these variables to be of high quality.

In this paper, we are concerned with SAT 2, the results of the test taken at the age of 11. For this reason, only schools in which children take this test are included in the data. Such schools take two forms: primary schools, which cater for children aged 4 to 11; and junior schools, which take children from the age of seven to the age of 11. Both types of schools are included in the sample, as we are interested to know if there is evidence that continuity in the same school results in better test results. Special schools were excluded from the sample, as they operate in a different way under a different funding formula. Very small schools, those with intakes of 10 or less, were also excluded.

Size, in the form of total school roll, is an important variable to take into account, as it determines the total budget. It could be claimed that, since the formula used for funding purposes determines the school budget in terms of the number of children plus a contribution to overheads, and a supplement for special education needs, all schools are equally financed and the size of the school roll should not make any difference. There are opposing views as to the impact of school size. It can be argued, on the one hand, that primary schools should develop a family atmosphere, and that this is better achieved in small schools. The opposite view is that the larger school can appoint a range of teachers who specialise in different skills, and that this should be to the benefit of the children. This matter has been extensively researched but the results are largely inconclusive[12]. Closely related to size is the number of teachers employed at the school. This information was also collected.

Class size is a difficult variable for interpretation purposes. In principle, other things being equal, class size is an indication of intensity of resources employed, the smaller the size of the class the more learning resources are directed to the individual child and results should be better[13]. However, one has to take into account confounding influences when including this variable in any model. Large schools will have many full classes and this will impact in a large average class size. If large schools are in deprived areas, then large class sizes will be associated with poverty. Another influence on class size is parental choice. If a

school is successful in attracting children from outside the catchment area, and this happens mainly in the more prosperous districts, then large classes will be associated with wealth[10].

Exclusions can be seen as a symptom of a discipline breakdown. They can also be a reflection of emotional deprivation, and a consequence of family and social breakdown[14]. Thus, a high level of exclusions should be an indication that the school is operating under difficult social conditions and we should expect lower academic results. The alternative viewpoint is that excluding children who disrupt the learning process would be good for the rest of the class and would result in better test scores.

The identification and funding of Special Education Needs (SEN) varies from LEA to LEA[15,16]. Following the Warnock[17] report and the 1981 Education Act, all three education authorities included in the sample declared an intention to integrate children with special needs in the mainstream. The data collected here includes both children with statements and children without statements. Schools are given extra funding based on a SEN audit. In theory the extra funding should compensate any school for the extra work required to deal with SEN, but it is possible that the money is not sufficient to do so. It is also possible that, by funding SEN facilities, the whole school may benefit.

As it is normal in this type of study, free school meals is taken as an indicator of poverty. The relationship between deprivation and results has long been established, and should always be taken into account when assessing the performance of a school.

More controversial information is also available in the database. This includes proportion of lessons described by OFSTED inspectors as good or excellent, value for money, and percentage of parents who comment favourably on the school. These are all a matter of opinion. Any attempt to include them in the analysis faces the same problems that are usually encountered when dealing with ordinal data: lack of an objective scale of measurement, and the fact that different people interpret the same reality in different ways.

OFSTED inspectors give an overall opinion of the school in the form of a value for money

judgement. This takes the form of an adjective and was translated into a five point scale. When a school is described to be "unsatisfactory" there was no doubt about what the correct class to be selected, but other cases were more ambiguous. We used judgement to translate the adjective into a number. This is clearly unsatisfactory, but we were interested to find out up to what point the conclusion arrived at by OFSTED coincides with the results of the DEA analysis.

In total, data was collected on 19 variables for 176 schools, although not all the data was available for all the schools. A list of the variables included in the analysis and their definitions is given in Appendix 1.

PRELIMINARY STATISTICAL ANALYSIS

In order to obtain some insights into the characteristics of the data set, a series of statistical analyses were performed. These are Principal Components, Factor analysis (both rotated and unrotated), Hierarchical Cluster analysis and Multidimensional Scaling. Dummy variables were excluded in this part of the study, so that only fourteen variables were included. Schools were taken as observations.

Before proceeding to the use of multivariate techniques we calculated, and examined, the values of correlation coefficients between variables. Correlations tended to be low. There were few significant values. We will now comment on these. The highest correlations were to be found between the results of the SATs. SAT results were negatively correlated with free meals, SEN, and exclusions. We found class sizes to be positively correlated with roll size, free meals and SEN, suggesting that larger schools are more likely to be found in deprived areas in Hampshire, Southampton and Porstmouth. Exclusions were positively correlated with free meals and SEN, confirming that the worst behaviour is to be found in deprived areas. The opinion that OFSTED inspectors had of the school was positively correlated with the percentage of parents who commented favourably on the school, indicating that they shared a common perception of the school. One of the highest positive correlations to be found was the one between quality of teaching and inspector

overall evaluation of the school. Inspector opinions' were also positively correlated with SAT results, but uncorrelated with SEN, free meals, and exclusions, suggesting that inspectors are more influenced by the academic results obtained and by their classroom observations, than by the conditions under which they are achieved. Finally, the quality of teaching was positively correlated with SEN but uncorrelated with free meals, suggesting that good teachers are to be found everywhere and that teachers do their best when faced with the most difficult children.

The limit for eigenvalue extraction in Principal Components was set to 0.8, following Jolliffe's[18] suggestion that setting a limit of one may be "throwing away too much information"[19]. It was found that the first four components accounted for 64% of the variance in the data. The percentage accounted for increased to 78% when the next two components were included. This suggests that there are between six and eight aspects to be taken into account when describing a school. The value of the eigenvalues and the variance explained can be seen in Table 1.

TABLE 1. Results of Principal Component Analysis.

COMPONENT	EIGENVALUE	% OF VARIANCE	CUMULATIVE
1	3.95	28.22	28.22
2	2.85	20.34	48.56
3	1.21	8.65	57.21
4	1.05	7.51	64.73
5	1.02	7.29	72.02
6	0.89	6.35	78.37

Factor analysis explored further what these characteristics are. Following the result of PCA, six factors were extracted. The analysis was performed with unrotated, and varimax rotated. There were few differences between the two results, and only the rotated solution is described here. The loadings for the rotated solution can be seen in Table 2.

Academic results (English, Mathematics, and Sciences) load high on the first factor. This factor is also positively influenced by the proportion of children who are not in receipt of free meals, and by the proportion of children who do not have special education needs.

TABLE 2. Factor loadings for varimax rotated solution

VARIABLE	FACTOR 1	FACTOR 2	FACTOR 3	FACTOR 4	FACTOR 5	FACTOR 6
CLASSIZE	0.19	-0.83	0.01	-0.07	0.05	0.00
ENGLISH	0.87	0.04	0.13	0.02	0.02	-0.02
EXPENDITURE	-0.13	0.83	0.15	0.07	0.06	-0.05
FAVORANSWER	0.04	0.06	0.03	0.96	0.02	0.03
MATHS	0.85	-0.07	0.09	0.16	-0.06	-0.03
NONFREEMEAL	0.84	-0.05	-0.12	-0.22	-0.17	-0.03
NONSEN	0.62	-0.16	-0.49	0.04	-0.24	0.08
EXCLUSION	-0.22	0.03	-0.02	0.02	0.94	-0.04
GIRLS	-0.07	-0.02	0.01	0.02	-0.03	0.98
QUALITYTEACH	0.12	-0.03	0.92	0.03	-0.05	0.03
ROLL	-0.27	-0.78	0.12	0.08	-0.13	-0.15
SCIENCES	0.83	-0.15	0.03	0.14	-0.13	-0.06
SURVEY	0.33	0.35	-0.12	0.29	-0.23	-0.16
TEACHPUPIL	-0.17	0.89	0.06	0.04	-0.05	-0.09

The variables that loaded high on the second factor were, on the positive side, expenditure per pupil, and teacher pupil ratio. These are two closely associated variables, as the main component of expenditure in any school is the number of staff. On the negative side are roll and class sizes. It is clear that this factor is associated with school size.

The third factor is associated with the quality of teaching, as perceived by OFSTED, as can be seen by the high loadings that this variable has in this factor. The fourth factor is highly influenced by parental opinion, the fifth by the proportion excluded, and the sixth by the proportion of girls in the school.

Summarising, when describing a school one has to take into account the academic results achieved, and the social context in which they have been achieved, the size of the school, the quality of the teaching, parental support, sex mix, and the level of disruption as measured by the number of exclusions.

It is possible to represent these findings in a graphical form by means of Multidimensional Scaling (MDS) techniques. To obtain the MDS representation, variables were first

standardised to zero mean and unit variance. The euclidean distance between standardised variables was used as a measure of distance. To help with the interpretation of the configurations, the results of cluster analysis were superimposed on the graph. Only the projections of the configuration in the first four dimensions were represented. The results can be seen in Figures 1 and 2 (appendix). It is to be noticed that the results of English and Mathematics SAT were highly correlated: they plot next to each other in the map, and form the first cluster in the dendogram.

DATA ENVELOPMENT ANALYSIS

The use of Data Envelopment Analysis in Education has a long pedigree[20-35]. DEA is particularly appropriate in the area of education management, given the special characteristics of the production process that takes place in schools[36].

In order to assess productive efficiency, it is necessary to specify the model, choose relevant inputs and outputs, and evaluate the results. In what follows we pay particular attention to these aspects.

1.- Model specification.

Schools have to operate with the resources that have been allocated to them, and try to obtain the best outputs from these resources. Thus, the output oriented DEA model is naturally the correct specification. Many of the variables considered for inclusion in the model are percentages and therefore bounded between zero and one hundred. This is particularly true of outputs. This suggests that one should use the variable returns to scale (VRS) specification, although we will also consider the possibility of relaxing the model to Constant Returns to Scale (CRS). It also appears to be sensible to start with the more general methodology, the VRS of Banker, Charnes and Cooper[37] and test if the CRS specification of Charnes, Cooper and Rhodes[38] is supported by the data. Considering that some of the variables, such as percentage of children who qualify for free school meals, are environmental, we have used the modification introduced by Banker and Morey[39].

2.- Input/Output selection.

Model selection procedures follow the methodology proposed by Pastor et al[40]. Pastor et al ask the question of how a variable contributes to the efficiency measure in DEA. They estimate the DEA model twice, first when the variable has been included (total model) and, second, when the variable has been excluded (reduced model). For any DMU, let ρ be the ratio of its efficiency in the reduced model over its efficiency in the total model. Pastor et al show that a value of ρ close to unity indicates that the additional variable does not significantly change efficiency and can be eliminated. If the value of ρ differs significantly from unity in a substantial number of DMUs, then the variable exerts a discernible influence on the efficiency of the centres and should be kept in the formulation. Pastor et al. exclude variables if less than 15% of DMUs are associated with a value of ρ of 0.9 or less. We have used this rule, but we have also used other more traditional tests, such as calculating correlations between the efficiencies of DMUs in the total model and the reduced model. We used two correlation based tests, one based on Pearson's correlation coefficient, and another one based on Spearman's rank correlation coefficient. In our particular case all three tests pointed in the same direction. Here we only comment on the results of the Pastor et al test.

The first step in the implementation of this methodology is the identification of the variables that may reflect relevant aspects of the educational process. Hanushek[41] gives a review of the theoretical and empirical literature on educational production functions. This review suggests that three minimum aspects should be taken into account when assessing the efficiency of a school: academic results, school inputs and environmental factors. This is in agreement with the results of our preliminary data analysis, which identified academic results and free school meals as important aspects of the first factor, and size and teacher pupil ratios as determinants of the second factor, the two first principal components accounting for 47% of the total variance.

Following from this, our first model contained three variables: teacher pupil ratios,

percentage of pupils not eligible for free meals, and percentage of pupils who achieve level 4 or more in English SAT 2. This model (model 1) was extended with the addition of Mathematical results and the extra variable was found not to significantly contribute to the explanation of efficiency. This is not surprising due to the high correlation that exists between English and Mathematics results. We next introduced Science results as an output (model 3). This was found to have a strong impact on efficiency and the variable was retained. This suggests that Science tests capture aspects of learning not covered by either English or Mathematics. Other variables introduced, and discarded, were the proportion of girls, the proportion of pupils who do not have special educational needs, the expenditure per pupil. The model which contained the Science output was considered for extension in step 2 but no variable was found to substantially contribute to the explanation of efficiency.

In the next step, step 3, reductions in specification were considered. We observed the crucial role of the environmental input, free school meals, on efficiency, in line with the findings in the literature[41]. This input was, therefore, kept in the final formulation. It was also observed that teacher pupil ratios were not necessary to explain efficiency and this variable was excluded from the model. This may be a reflection of formula funding, which attempts to equalise resources per pupil in all schools within a given LEA.

We used the ratio of CRS efficiencies to VRS efficiencies[37] to establish that there are no discernible scale inefficiencies. However, we retained the VRS model. The reason for choosing the VRS model is as follows. All the variables that enter the final specification are measured in percentages and are, therefore, bounded between 0 and 100. The CRS model allows for extrapolation beyond the observed range of values. It is possible, for an inefficient DMU to be set a target which is an extrapolation of observed values, and there is not guarantee that this target will be bounded by the 100 upper limit. This does not happen with the VRS model which allows only for interpolation within observed data.

The preferred model, model 13 in Table 3 (appendix), contains NONFREEMEALS on the side of inputs, and ENGLISH and SCIENCE on the side of outputs, under the assumption

of variable returns to scale. The model selection procedure is summarised in Table 3.
Our final model coincides with the one proposed by Thanassoulis and Dunstan[34] in that it does not contain any controllable input. Thanassoulis and Dunstan do, however, include the results of a verbal ability test on entry as an additional input. We did not have data on such a variable as we did not have comparable information. In recent years SAT 1 results are being published, but this has only taken place during the last two academic years. We decided not to use SAT 1 results since they did not relate to the same children as those who took the SAT 2 tests. It is now well established[42] that if information on entry qualifications is incorporated in a model to compare institutions, the data on entry should correspond to the same children whose performance is being assessed.

3.- Results

The estimation of the selected model resulted in an average efficiency of 78.50%, pointing out to the possibility of improvements in academic standards, in line with current government initiatives. The minimum efficiency score found was 41.7%. Only eight of the 176 schools were found to be efficient. Three of the efficient schools appeared frequently in the reference set of inefficient schools. School 117, appeared 110 times; school 166 appeared 80 times; and school 157 appeared in 60 times. All three schools are of religious denomination. This aspect will be further explored in the next section.

Efficiency results were correlated with the "value for money" opinion of OFSTED reports. Despite the difficulties in allocating opinions to classes, we found a significant, but small (0.27) correlation between the two variables. It is clear that the coding process introduces errors, and that this reduces the size of the correlation, but also that efficiency, as measured by DEA, is far from a good explanation of value for money, as seen by the inspectors.

EXPLAINING INEFFICIENCY

In this section we concentrate on possible exogenous sources of inefficiency. We define inefficiency as the amount by which the DEA efficiency value, measured in percentage

terms, fails to reach the value 100. Are there external factors, other than parental background, that influence the academic results achieved in a school? Possible relevant factors are the religious orientation of a school, class size, the presence or absence of children with special education needs, the level of disruptive behaviour in the school, the proportion of girls, the quality of teaching, the size of the school, and parental support.

From the institutional point of view, there are two types of religious schools: aided and controlled. Aided schools belong to the church but are subsidized by the state. Controlled schools belong to the state but have a religious orientation. Only two religious denominations operate under these arrangements: the Church of England and the Roman Catholic Church. There are very few aided catholic schools in the area under examination, and we have treated all catholic schools in the same way, although we have taken into account if a Church of England school is aided or controlled.

Parental support for a school is difficult to measure. Rather than attempt to measure it, we have taken as a proxy the proportion of parents who respond to the OFSTED survey. Another aspect of interest is up to what point parental perceptions rebound into the efficient running of the school. This could take place through an agency type mechanism. A school contains a series of agency type relationships. Parents are the ultimate "customers". There could be a mechanism which works in two directions: schools may do their best to take actions which satisfy the opinions of the parents, and parents may chose school on the basis of the opinion that other parents have of the way it works. This mechanism is implicit in the legislation on parental choice and local management of school, which results in lower bureaucratic relationships and more local control[43]. Therefore, the proportion of parents who comment favourably on the school in the OFSTED survey was included as an explanatory variable.

The use of regression to explain DEA results in education is now well established[33]. Some authors observe that efficiency is bounded between zero and one, and that linear regression can produce estimates that exceed these limits. McCarty and Yaisawarng[32] argue that efficiency is a variable which is observed with censoring or truncation, and estimate the

regressions using the Tobit model. We do not share this opinion. We prefer to think that efficiency takes the natural limits of zero and one, that a non-linear relationship between efficiency and explanatory variables is plausible, and that the regression model should be heteroscedastic: less uncertainty in the estimates should be associated with values of efficiency which are near zero or near one, and more uncertainty with values which are near the middle of the range.

All these objectives can be achieved by estimating a model of the logit type, such as:

$$\ln \frac{inefficiency}{100 - inefficiency} = \sum b_i X_i + error$$

No zero efficiency cases were present in the data set, but for the eight schools which had efficiency one the logarithm was not defined, and these were excluded from the regression, thus the regression equation attempts to explain the reasons why schools fail to achieve full efficiency.

The correlations between the variables that enter the model are low, most variables being almost orthogonal to each other. Under these circumstances model selection procedures should produce the same results, but we have preferred to follow the methodology based on starting with a general model and testing for simplifications. If one proceeds in this way, the testing framework is correctly specified and test to be carried out are well known[44].

Initially, the variables included in the model were: CATHOLIC, CLASSIZE, CofEAIDED, FAVORANSWER, JUNIOR, CofENONAIDED, NONSEN, EXCLUSION, GIRLS, QUALITY, SURVEY and ROLL. There was incomplete information for some of the schools and these were excluded from the data set. The complete model had 133 degrees of freedom. The regression had a coefficient of determination (R^2) of .2. Variables were removed one by one, on the basis of the t statistic, starting with the lowest value of t, and the model was re-estimated every time.

The first variable to leave the model was JUNIOR (t = -0.089), indicating that there is no evidence in the data set to support the view that junior schools are any more efficient or inefficient than all-through primary schools. The influence of children with special education needs had already been explored when defining the DEA model and was found not to be significant, nevertheless the variable NONSEN was included in the regressions, but was the second one to be discarded (t = -0.3). The next variable to leave the model was QUALITY (t = -0.6), suggesting that teachers who are perceived by OFSTED to deliver poor classes, have no discernible influence on academic results at the age of 11. ROLL (t = 0.6) left the model next, followed by CLASSIZE (t = -0.7). No influence of school or class size on efficiency was found. The next variable to be excluded was CATHOLIC (t = 0.8) suggesting that there is no difference in efficiency between catholic schools and ordinary maintained schools. The final variable to be excluded was GIRLS (t = 1.2). The final model contained the following variables:

TABLE 4. Results of regression analysis.

VARIABLE	COEFFICIENT	T VALUE
CofEAIDED	-0.752	-1.8
FAVORANSWER	-0.013	-1.8
CofENONAIDED	-0.496	-2.4
EXCLUSION	0.152	2.1
SURVEY	-0.014	-2.4

The coefficients of the variables CofEAIDED and FAVORANSWER are significantly different from zero at the 10% level, the others are significantly different from zero at the 5% level.

It can be concluded that parental support has a significant, but small, influence on the school. Schools where parents take an interest, as demonstrated through the willingness to fill in a questionnaire, are more efficient (less inefficient). The presence of the variable

that measures favourable parental opinions gives support to the theory that schools react to their opinions, and emphasises the importance of parental choice to the survival of the school. Exclusions are associated with inefficiency. This suggests that exclusion is a reflection of the general atmosphere of the school, since high exclusions are due to a high level of disruption. Finally, Church of England schools, other things being equal, are substantially more efficient at producing academic results than the rest of the schools. Whether there is something in the ethos of the school or in the family values that lead to this result, it is not possible to establish with the present data set.

CONCLUSIONS AND DISCUSSION

The raising of academic standards was made a national priority in 1998 both by Central and Local Governments. Standards were defined as the proportion of children who achieve more than a certain grade in Standardised Assessment Tests. Local Government is also under pressure to reduce the number of spare school places. Education officers are responsible to implement both policies. They may have to close schools for reasons of efficiency and they have to set achievement targets for schools. Although nobody objects to better education results, school closure programmes are unpopular. It is, therefore, tempting to rationalise the motives for closing schools with the argument that this is good on educational grounds. We have reviewed current trends in education at the national level and we have illustrated their impact at the local level.

We have tried to address the question of how far available information can be used to assess if a school is achieving the best possible results with the resources available under the conditions in which it operates. We obtained the data from inspection reports, available in the OFSTED database. This is a rich source of information both on quantitative and qualitative data. The technical approach used was Data Envelopment Analysis, a Linear Programming based approach.

We took the view that school outputs are academic. This is a limited view of achievement, although the it can be argued[45,46], that it is difficult to find anything better. We reviewed

existing literature on what are the relevant inputs to include in the model, and found that the main input that limits the results that can be achieved is socio-economic background, which we measured, as it is common in studies of this type, through the free school meals indicator. A model selection procedure based on comparison between the total model, which includes the candidate variable, and the reduced model, which excludes it, was followed to obtain our preferred formulation. An exploration into the reasons why schools fail to achieve full efficiency found little explanatory power in most possible explanatory variables.

The only influences that we found on efficiency are religious orientation, with Church of England schools being more efficient than the rest, parental support, as reflected in the OFSTED report, and the level of disruption in the school, as measured through the incidence of exclusions. We found that neither children with special education needs, nor the proportion of girls in the class, nor the proportion of bad lessons, nor teacher pupil ratios, influence efficiency in the attainment of good academic results. We did not find evidence to support the view that small schools are inefficient, or that continuity of education is better than a split between junior and infant school.

A possible interpretation of our results is that by concentrating on those children who do best in examination results, we are censoring our sample, and we are observing conditional correlation phenomena[47]. In other words, it is possible for variables such as the quality of teaching to have an impact on the academic results of the children, but in order to observe it we have to look at all the children in the class and not only at those who do best. This observation would also apply to national and local interpretations of what is meant by "raising standards". Goldstein and Thomas[48] have already warned about the possible problems of comparing institutions using aggregated data. We can only agree with their findings.

Our study fails to explain much of the variability in efficiency between schools, but this should not be seen as a failure. Schools are complex organisations, they operate in a given environment with certain resources. Individuals interact in them. This results in a

particular atmosphere which gives every school an ethos. Purkey and Smith[49] point out that effective schools cannot be described as a sum of ingredients, but as a culture of activities and expectations. The study of what creates this culture and how it evolves requires both quantitative and qualitative studies at school level. We think that in the understanding of what creates this culture lies the future of efficiency studies in education.

We have also failed to find support for the hypotheses put forward by Southampton LEA as a basis for policy. It is possible that this LEA might have performed appropriate studies of relevant data, but since neither the data nor the methodology were disclosed, there is no way in which their views can be justified. One interpretation would be that the study, if any, was a mere rationalisation to justify decisions already taken, a view often expressed in Operational Research[50,51]. But even if policy decisions follow a thorough examination of relevant evidence, this should be made public for all to examine, as different approaches to data analyses can point towards different actions. If an example is needed, this is provided by Ashford, Butts and Bailey[52]. Public bodies should be open to public examination of their methods: when one has a light one puts in the middle of the room for all to see, and does not hide it in a cupboard.

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