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Does Money Matter for Schools?

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ABSTRACT

Does Money Matter for Schools?*

There is considerable disagreement in the academic literature about whether raising school expenditure improves educational outcomes. Yet changing the level of resources is one of the key policy levers open to governments. In the UK, school expenditure has increased by about 40 per cent in real terms since 2000. Thus, providing an answer to the question as to whether such spending has an impact on educational outcomes (and whether it is good use of public money) is of paramount importance. In this paper we address this issue for England using much better data than what has generally been used in such studies. We are also able to test our identification assumption by use of a falsification test. We find that the increase in school expenditure over recent years has had a consistently positive effect on outcomes at the end of primary school. Back-of-envelope calculations suggest that the investment may well be cost-effective. There is also some evidence of heterogeneity in the effect of expenditure, with higher effects for students who come from economically disadvantaged backgrounds.

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1. Introduction

Whether raising school expenditure is an effective way to improve educational outcomes is a contentious issue. Hanushek (2008) argues that accumulated research says that there is currently no clear, systematic relationship between resources and student outcomes, with the implication that conventional input policies are unlikely to improve achievement. However, a critique of this argument would point to a number of high quality studies that suggest otherwise.[2] Well-known examples include the paper on class size in Israel (Angrist and Lavy, 1999) and the experimental Tennessee STAR class size reduction papers (Krueger, 1999; Krueger and Whitmore, 2001). A difficulty with this debate is that studies with an excellent methodological design are rare and data available to researchers usually falls well short of the ideal. Thus, it is not clear how far one can use the literature to give policy advice on whether or not governments should raise the amount of money they spend on school education.

In the UK, education is the third largest area of government spending (of which school spending has the largest share). Since 2000, school expenditure has increased by about 40 per cent in real terms for both primary and secondary schools (see Figure 1).[3] The question as to whether such investment is worthwhile is of central importance. The national debate is not revealing as to the answer. The government points to the improvement in the number of students achieving government targets in national tests whereas critics argue that this simply represents 'grade-inflation' and 'teaching to the test'.

[2] The two sides to the argument are discussed in detail by Hanushek (2003) and Krueger (2003). For earlier reviews of the literature, see Hanushek (1986; 1997).

[3] Government statistics show a decline in the pupil-teacher ratio over time. Currently, 88 per cent of primary pupils are taught in a class of no more than 30 pupils compared to 78 per cent in 2000. http://www.dcsf.gov.uk/trends/index.cfm?fuseaction=home.showIndicator&cid=3&iid=15

In this paper, we address this issue for English primary schools. We use census data available on all pupils completing state primary schools between 2001/02 and 2006/07.[4] This includes measures of academic achievement on national (externally marked) tests of English, Mathematics and Science at age 11 (our outcome measures); similar measures of prior attainment (on the basis of tests at age 7); and indicators of gender, ethnicity and socio-economic deprivation. The data set can be linked to the school-level census for relevant years, which includes school expenditure. Thus, a unique feature of our data set is that it contains detailed information on school-level expenditure, for all English state primary schools, over a time period of eight years. Since we have a panel of schools, it is possible to remove the effect of time-invariant, unobserved school characteristics that potentially affect both expenditure and pupil achievement in tests. The fact that the data set is a pupil-level administrative data set, representing a census of English school children over a number of years, and containing measures of current and prior academic achievement (as measured in national tests that are external to the school), as well as unique expenditure data, makes this a much better data set than what is typically available to researchers who have analyzed this question. This matters because we are able to overcome methodological difficulties without the need for a sophisticated experiment (which unfortunately is not available to us) and are able to address the issue as to whether increases in pupil expenditure matter on average for the population (Instrumental Variable estimates identify an effect only for the sub-population that is affected by the instrument).

Much of the focus of the literature has been on the pupil-teacher ratio as a measure of school resources. While this is the main school input (in terms of cost), we would like to highlight the fact that using *direct expenditure per pupil* is a more general approach, allowing

[4] Only a minority of children attend private schools in the UK, and it is especially uncommon for the years of primary schooling.

the estimate to reflect expenditure effects through channels other than class size, such as teacher quality. Although this approach does not open up the 'black box' of school expenditure mechanisms, it is in fact highly policy relevant, since the policy-maker cannot always prescribe what schools do with their money, but has a greater role in determining the level of resources passed on to schools. Thus, from the policy-maker's perspective, the 'reduced-form' effect of increasing school resources is highly relevant, and also gives an idea of whether schools are able to translate spending increases to improvements in educational output.

In the literature about the effects of school resources, one of the main difficulties has been that there is a strong redistributive component in how resources are allocated to schools (at least in the UK and the US). If this is not taken into account, there is a high risk of downward bias in the estimate of the effect of school resources on academic achievement. This is one argument for why so many studies find no apparent effect of resources on achievement. We show that by controlling for the range of pupil and school-level characteristics available to us (and taking out the school fixed effect), the sign of the estimated effect of school resources on pupil achievement changes from negative to positive (and is statistically significant). Moreover, this effect is of a similar magnitude for all three subjects (English, Mathematics and Science) and corresponds to about 5 per cent of a standard deviation. We are able to identify effects after including so many controls because of the complicated system of funding schools. The system has many idiosyncrasies at the local level, and the sharp increase in school spending since 2000 has also been accompanied by numerous changes at the national level. The changes over time implied by government regulations are thus exogenous to decisions made at school level.

Although we are not able to prove our identifying assumption (that the error term is randomly distributed), we apply a simple falsification test, where we show results which

support our argument that the positive effect of expenditure on achievement represents a causal impact. Specifically, we find that a positive effect of expenditure on achievement only occurs if the spending has taken place during the pupil's time in primary school; it has no effect if it takes place the year after the pupil has left their primary school (and entered secondary school). This finding is convincing and suggests that the estimated positive effects of school expenditure are not driven by an unobservable factor. If one accepts the assumption of our analysis, then it is legitimate to interact average expenditure with pupil-level characteristics and consider whether there might be heterogeneity in the effects of expenditure. We find that expenditure has had a higher impact for pupils who are more economically disadvantaged, but there seems to be little heterogeneity in expenditure effects based on pupils' ability or whether they speak English as a second language.

Our paper has the following sections. In Section 2, we describe relevant features of the English system of education. In Section 3, we describe our data. In Section 4, we outline the methodology and report our results. We conclude in Section 5.

2. The English System of Education and Funding to Schools

The years of compulsory schooling in England are organized into various 'Key Stages'. At the end of each Key Stage (at the age of 7, 11, 14, and 16), there is a national test that is marked externally to the school. The results at the end of primary school (i.e. the end of Key Stage 2, at age 11) and secondary school (the end of Key Stage 4, at age 16) are especially important because they are published in the School Performance Tables, which are publicly available. At age 7 pupils take national tests in Mathematics and English; at age 11 and 14, national tests cover Mathematics, English and Science; and at age 16, the national tests are taken in a wide range of subjects. In this paper, results in the tests at the end of primary

school are used as our outcome variables. We use the results of the earlier (age 7) test as a proxy for prior ability/human capital.

There are about 13,000 primary schools in England and most of their funding goes through Local Authorities (of which there are 150).[5] During the time period covered in this study, about 75-80 per cent of Local Authority education resources came from central government, while most of the rest was financed by local taxation. Once the funding gets to schools, the decision about how to spend it is up to the headteacher and governing body (although they are constrained by national pay agreements in the extent to which they can increase teacher salaries). Appendix Table 1 shows different categories of expenditure. Although expenditure levels have increased dramatically, the way in which it is spent (at least in terms of these broad categories) has not changed much over time.[6] About 60 per cent of expenditure is accounted for by teachers and a further 20 per cent by either support staff or other staff. Building and Maintenance accounts for about 6 per cent; Learning resources/IT for about 5 per cent; and a residual category for 8 per cent.

Funding is allocated from central government to Local Authorities mostly on the basis of pupil numbers, measures of deprivation, ethnicity and area costs. The Local Authorities distribute funding to schools based on formulae, which vary between Local Authorities. The existence of formula funding means that there is horizontal equity within each Local Authority as all schools are funded by the same set of rules (Levăcić, 2008). However, there is considerable heterogeneity between Local Authorities in the formula used.[7] For example,

[5] They are also responsible for the strategic management of local authority education services including planning the supply of school places, ensuring every child has access to a suitable school place and intervening where a school is failing its pupils.

[6] Government statistics show a decline in the pupil-teacher ratio over time. Currently, 88 per cent of primary pupils are taught in a class of no more than 30 pupils compared to 78 per cent in 2000. http://www.dcsf.gov.uk/trends/index.cfm?fuseaction=home.showIndicator&cid=3&iid=15

[7] The formula used by Local Authorities must take into account pupil numbers. The remainder of the formula may include factors from a 'menu' set out in regulations, including special educational needs, pupils for whom English is not their first language, pupil mobility, characteristics of the school buildings and site, use of energy by schools, salaries at a school, incidence of pupils from ethnic minority groups having below average levels of

this was revealed with respect to the proportion of funding passed on to schools on the basis of deprivation (according to information collected for a subset of Local Authorities in 2004/05, DfES/HM Treasury, 2005). Findings include the following: "there is a wide degree of variation between local authorities' strategies for assessing and funding the costs of deprivation, and there has often been no systematic approach to reviewing need."; "schools facing the same scale of deprivation in different authorities often receive different amounts of funding from their authorities to deal with deprivation." To illustrate that there is much school-level variation in the amount of per pupil expenditure (even for a given level of deprivation), in Figure 2 we show a plot of the distribution of per pupil expenditure for two years (2002 and 2007) within each category of socio-economic deprivation (measured in quartiles and based on the school's percentage of pupil eligible to receive Free School Meals). Points to note are that within each quartile, there is a distribution of expenditure per pupil and that this has widened over time; also, there are schools in the highest quartile of deprivation that have the same amount of expenditure per pupil as schools in the lowest quartile. Thus, across Local Authorities, there is much variation in school resources, even after accounting for major determinants of resource allocation such as pupil numbers and an indicator of deprivation.

During the time period that we focus on, 2002-2007, there have been changes both in how funding is allocated from central government to Local Authorities, and in regulations about how Local Authorities pass on funding to schools. A major change in how central government allocated funding to Local Authorities took place in 2003/04. This involved a change in the funding formula at the national level and the indicators used to measure 'additional educational needs' (see West, 2008). The part of the formula that deals with area

academic achievement in relation to other pupils in the local authority area, prior attainment of pupils entering a school (West, 2008).

costs has also changed over time. Since 2006/07, the funding allocated to Local Authorities has been 'ring-fenced' (i.e. they are obliged to pass it all on to schools, whereas previously they could spend part of the education budget on other services).

At the local level, changes that affect how Local Authorities pass on funding to schools include changes in the percentage of funding that must be 'pupil-led'[8]; an obligation (from 2002/03) to include a factor in their formulae based on the incidence of social deprivation in their schools; and a 'minimum funding guarantee' in 2004/05 which guaranteed that each school would get a per pupil increase and an increase for fixed costs.

This description shows that in recent years there has been much (regulatory-inspired) change in how funding is allocated to schools. Unfortunately, we do not have information about how Local Authorities have changed their own funding formulae over time. But we know enough to say that the formulae are heterogeneous and thus change over time has varied between different Local Authorities and schools. Conditional on a broad set of controls, it is therefore likely that changes over time are idiosyncratic (such as how deprivation is measured at the local level) [9] as well as influenced by changing regulations. Thus, there is good reason to argue that there is exogenous variation in school expenditure which is left after one conditions on school and pupil characteristics. Unfortunately, it has not been possible to use any of these changes individually as the basis of an Instrumental Variable Strategy.[10]

[8] 'Pupil-led' means funding that has the same value for pupils of a certain age regardless of school attended. This change from 80 per cent to 75 per cent in 2002/03. It was abolished as a rule in 2006/07.

[9] The indicators of 'additional need' in the national formula changed in 2003/04 (i.e. the formula determining the allocation of funding from central government to Local Authorities). These measures were higher quality than before as a result of pupil-level administrative data being collected by individual schools from 2002 onwards (West, 2008). The availability of higher quality data may also have influenced Local Authorities to change the basis of their individual formulae.

[10] Holmlund et al. (2008) report on various possible strategies. However, these have not produced a strong enough 'first stage' to be used as part of an IV strategy. Furthermore, we do not have information on the formulae used by Local Authorities to allocate funding to schools (other than a survey of 38 LAs conducted in 2004/05). Finally, although the 2003/04 national change in funding formulae might seem to offer a good opportunity to construct an index of 'winner' and 'loser' Local Authorities, in practice the government

3. Data and Methodology

We use the National Pupil Database between 2001/02 and 2006/07 which is a census of all pupils in State schools.[11] We use information on the test scores of 11 year olds (i.e. at the end of Key Stage 2), which has been matched to their attainment at age 7 (i.e. at the end of Key Stage 1) and is also linked to information on pupil characteristics which include the following: gender, ethnicity; whether the pupil is known to be eligible for Free School Meals; whether English is his/her first language; whether he/she has a statement of Special Educational Needs or has Special Educational Needs without a statement. The data can be linked to school-level information in the Annual School Census (such as pupil numbers; pupil-teacher ratio; percentage of pupils known to be eligible for Free School Meals) and financial data on schools. Expenditure per pupil is used as the measure of school resources and in our main regressions, we use average expenditure over the last three years leading up to the Key Stage 2 assessment, to account for the fact that it is school expenditure for a number of years that matters for outcomes rather than expenditure in one year.[12] Summary statistics for the pupil level data set are shown in Appendix Table 2.

We estimate an Educational Production Function, which can be described as follows:

$$A_{ist} = \alpha_0 + \beta E_{st} + \gamma X_{ist} + \delta Z_{st} + \alpha_t + \mu_s + \varepsilon_{ist} \qquad (1)$$

deliberately mitigated the effects of the formulae change to Local Authorities (in a strategy known as 'dampening').

[11] We exclude students in Special schools from the analysis – and any students attending independent schools (although many such students would either not be in the data at all or only have incomplete information).

[12] The expenditure measure is expressed in 2007 prices, deflated using the GDP deflator. Our results are qualitatively similar if we use the pupil-teacher ratio as the measure of school resources. However, this is more problematic as a measure because in many primary schools, children are grouped by ability for certain subjects (especially Maths) in the final years of primary school. We only observe the pupil-teacher ratio for the year group and not for the class in which the pupil has spent most of his/her time. Furthermore, expenditure per pupil is a more general measure of school resources – headteachers may use this in any way they see fit rather than to reduce the pupil-teacher ratio. Finally, there is a potentially more serious endogeneity issue when using the pupil-teacher ratio as a measure of resources because even if expenditure per pupil can be thought of as exogenous (conditional on other controls), how exactly the money is spent may not be.

where A denotes the attainment of pupil *i* in school *s* at time *t*; E is average school expenditure per pupil (represented as an average of expenditure per pupil over the previous three years); X denotes pupil characteristics (including attainment at age 7, in the Key Stage 1 assessment), Z is a set of school characteristics and ε is an error term. The α_t term is a set of year dummies, included to capture year on year differences in pupil attainment. We add a full set of school fixed effects μ, to control for unobservable school characteristics that are constant over time. If this approach is valid, we can expand on it to identify the effect of expenditure per pupil on particular sub-groups by including interaction terms between expenditure per pupil and some of the pupil characteristics included in X.

Estimating equation 1 identifies the true causal impact of expenditure per pupil on attainment at the end of Key Stage 2 if all factors that are correlated with both expenditure per pupil and attainment are controlled for in the regression. We have improved on previous studies using a similar approach because we control for all time-constant school characteristics (whether observed or not) and detailed pupil characteristics.[13] This is potentially important here because Local Authorities may distribute funding to schools on the basis of school characteristics that are not fully measured in the available data (and these characteristics might also influence pupil attainment independently of the effect that they have on funding).

In the above Section, we have argued that time-varying changes in the way Local Authorities have allocated funding to schools (combined with the changes in how funding has been allocated to Local Authorities from central government) is a good reason for why we might expect (exogenous) variation in school expenditure even after we condition on all these school and pupil-level variables. It is crucial for our identification assumption that such

[13] Levăcić et al. (2005) and Jenkins et al. (2006) use this data to conduct a similar analysis for secondary schools, although they only use one cohort in their analyses.

variation is not generated by factors that might directly affect educational outcomes other than through expenditure.

Although we cannot directly prove the identification assumption, we can conduct a falsification test wherein we include expenditure inputs that took place when the pupil attended primary school and expenditure inputs that took place after the pupil had left primary school (which could not possibly influence his/her attainment). Specifically, we estimate the following:

$$A_{ist} = \alpha_0 + \beta_1 E_{s,t-2} + \beta_2 E_{s,t-1} + \beta_3 E_{s,t} + \beta_4 E_{s,t+1} + \gamma X_{ist} + \delta Z_{st} + \alpha_t + \mu_s + \varepsilon_{ist} \quad (2)$$

In this case, we include expenditure for each year separately (i.e. t-2, two years before the pupil undertook the test; t-1, one year before the pupil undertook the test etc.) and also include a measure of school expenditure the year after the pupil left primary school (t+1). If school expenditure is associated with pupil attainment because of an unobserved variable (which has some persistence), then the coefficient on expenditure the year after the pupil left primary school may be significantly related to the outcome variable. However, if the coefficients on expenditure reflect a causal impact, there can be no possible influence of this variable on the outcome variable. While this would not prove our identification assumption, it would nonetheless give good reason to interpret the coefficients on expenditure in a causal way.[14]

[14] If there were a transitory shock correlated with school expenditure and pupil outcomes, the 'falsification test' would be misleading. However, we think this scenario is unlikely.

4. The Effects of Expenditure on Outcomes

In Table 1 we show OLS estimates of the effect of average expenditure per pupil on various test outcomes at age 11: English (columns 1 and 2); Mathematics (columns 3 and 4); Science (columns 5 and 6). The outcome variables are the standardized test scores in these subjects.[15]

In each case, we show 2 columns – one when only average expenditure per pupil and year dummies are included and another where the full set of controls are included (i.e. equation 1). The more detailed specification involves controlling for everything about the school which does not vary over time (between 2001/02 and 2006/07) and many of the important pupil characteristics that would be expected to vary for different cohorts (i.e. age 7 test scores, ethnicity, Free School Meal eligibility, Special Educational Needs status, whether English is the first language of the pupil). The contrast between the two columns shows how important it is to include detailed controls. In the simple specifications, average expenditure per pupil is shown to be strongly negatively associated with pupil outcomes. This reflects the fact that school funding is strongly re-distributive. When we include detailed controls, the effect of expenditure per pupil on test scores is consistently positive and significant for all outcome measures. The results show that an increase of £1,000 in average expenditure per pupil (i.e. an increase of one third – close to the actual increase over the period of our data) would raise standardized test scores by 0.045, 0.055 and 0.054 standard deviations in English, Mathematics and Science respectively. Thus, in contrast to much of the literature (which often finds zero effects), we find good evidence of positive effects of school resources on attainment. An important question is whether the benefits are of sufficient magnitude to justify the cost involved. We discuss this in the next section.

[15] Scores are standardized to have mean zero and standard deviation one in each year.

As has been discussed above, we cannot directly test the assumption that expenditure per pupil is uncorrelated with unobservable variables that are also correlated with pupil attainment (even after controlling for a rich set of variables). However, we can comment on the plausibility of this assumption by implementing a 'falsification test'. Specifically, we look to see whether expenditure the year after the pupil left primary school still has an effect on their attainment. The results are shown in Table 2. In these specifications, rather than including 3-year averages for school expenditure, we include expenditure in different periods: t (when the pupil was in the final year of primary school) and two years before that (t-1; t-2). The period t+1 refers to the year after the pupil completed his/her test. If we believe that the coefficient on expenditure reflects its causal impact on attainment, then we should not see a significant relationship between this variable and test scores *after* the pupil has completed his/her test.

For all subjects, the coefficient on expenditure is positive and significant for all 3 years in which the pupil is actually in the school and working towards the assessment at age 11.[16] However, the coefficient goes to zero after the pupil has completed his/her tests and moved to secondary school. This is in line with a causal interpretation for the expenditure variable.

Finally, since the falsification test gives us reason to think that the OLS estimates do reveal the average causal effect of expenditure on outcomes, we turn to consider whether there is a heterogeneous effect of expenditure. We re-estimate equation (1) including interactions between pupil characteristics and the expenditure variable. In Table 3 we report results where the expenditure variable has been interacted with whether the pupil is

[16] The rationale for using 3 year averages for expenditure in our baseline regressions is that it is the spending over the time the pupil has been at school (rather than spending in a particular year) which is important for outcomes. Also using averages helps mitigate problems arising from measurement error. However, it is noteworthy that summing the coefficients for the 3 years in which the pupil was in the school gives similar estimates to those where average expenditure is used as the relevant variable.

economically disadvantaged (as measured by whether he/she is eligible to receive Free School Meals). The results suggest that the average effect of expenditure is higher for such pupils. Summing up the effects suggests that for a disadvantaged pupil, the average effect of increasing expenditure by £1,000 would be to increase attainment by 0.063, 0.073 and 0.071 standard deviations in English, Mathematics and Science respectively.

We have also interacted expenditure with pupil-level ability and whether he/she speaks English as a second language (not reported). In the former case, there is no difference between high and low ability students (as measured by attainment at age 7) in the effect of expenditure on age 11 tests. In the latter case, there is a slightly higher impact for those who speak English as an additional language.

5. Cost-effectiveness

If we take the OLS results as reasonable baseline estimates of the effect of pupil expenditure on test score outcomes, the next question to ask is whether the magnitude of effects is large given the cost. In other words, has the increase in school expenditure been cost-effective? This is a difficult question to answer because much depends on the consequences of improving these attainment measures for later outcomes.

We can compare effects estimated here to those estimated in international studies. For example, Krueger and Whitmore (2001) found a class size reduction in the STAR program to lead to an increase in test scores of 0.13 standard deviations. Costs are estimated at around half of total per pupil expenditure ($7502 at the time). This compares to our effects of about 0.05 standard deviations for about one third of per pupil expenditure (£1,000). In another study, Rivkin, Hanushek and Kain (2002) suggest that having a teacher at the higher end of the quality distribution raises student achievement by at least 0.11 standard deviations. However, it is difficult to know what it costs to improve 'teacher quality'.

Machin and McNally (2008) estimate the effectiveness of the 'literacy hour' in the late 1990s.[17] They find that this policy initiative raised reading scores by between 0.06 and 0.09 standard deviations at a very low cost. They produce a back-of-envelope estimate of the benefits such an increase in reading scores might produce in wages over the lifecycle (using the British Cohort Survey – those born in 1970 who are observed in the labour market at age 30). They estimate benefits of between £1375 and £3581 for an increase in the reading score by 0.06 standard deviations. Since we estimate an increase in pupil expenditure to lead to an increase in the English score of 0.05 standard deviations, the back-of-envelope calculation can also be applied in this context. On this basis, we would argue that the increase in school expenditure probably has been cost-effective. Moreover, this estimated wage benefit does not capture the expected returns from improved numeracy skills, nor any non-wage benefits of learning.

Finally, increasing parental choice and promoting competition between schools have been important components of government policy since the 1980s. It is noteworthy that using the same data set, Gibbons et al. (2008) find little evidence of a link between choice and competition and performance in English primary schools. Taken together with our results, this suggests that more traditional resource-based policies have been more successful for raising educational standards in English primary schools.

6. Conclusion

Whether increasing school resources has an effect on educational outcomes has been long-debated and hotly contested. The answer to this question is extremely policy-relevant because increasing (or reducing) school expenditure is one of the key levers open to policy makers to

[17] They evaluate the pilot, before the policy was rolled out nationally in 1998/1999. The 'literacy hour' involved a daily hour of teaching English. It provided a much more rigid and structured form on the curriculum for English teaching than what was previously in place.

try to influence educational standards. In the UK, there has been a dramatic increase in the level of school expenditure per pupil, after many years of stagnation. Using much better data than usually available to researchers (including school-level expenditure data and detailed pupil-level attainment data), we have been able to consider the question of whether this rise in expenditure has improved educational outcomes over the relevant time period.

The fact that there has been so much (regulatory-inspired) change to funding formulae suggests that there has been (exogenous) variation in school expenditure even after one conditions on school and pupil characteristics. We conduct a falsification test that supports the argument that our estimate of the effect of school expenditure on pupil outcomes reflects a causal impact. We find that school expenditure has a consistently positive and significant effect on all national tests taken at the end of primary school and has a higher effect for students who are economically disadvantaged. Thus, in contrast to much of the literature, we find evidence that a general rise in school expenditure can raise educational standards. Our analysis suggests that the English policy of increasing school spending over the past few years has been worth the investment.

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Figure 1
School Expenditure in England, Real terms

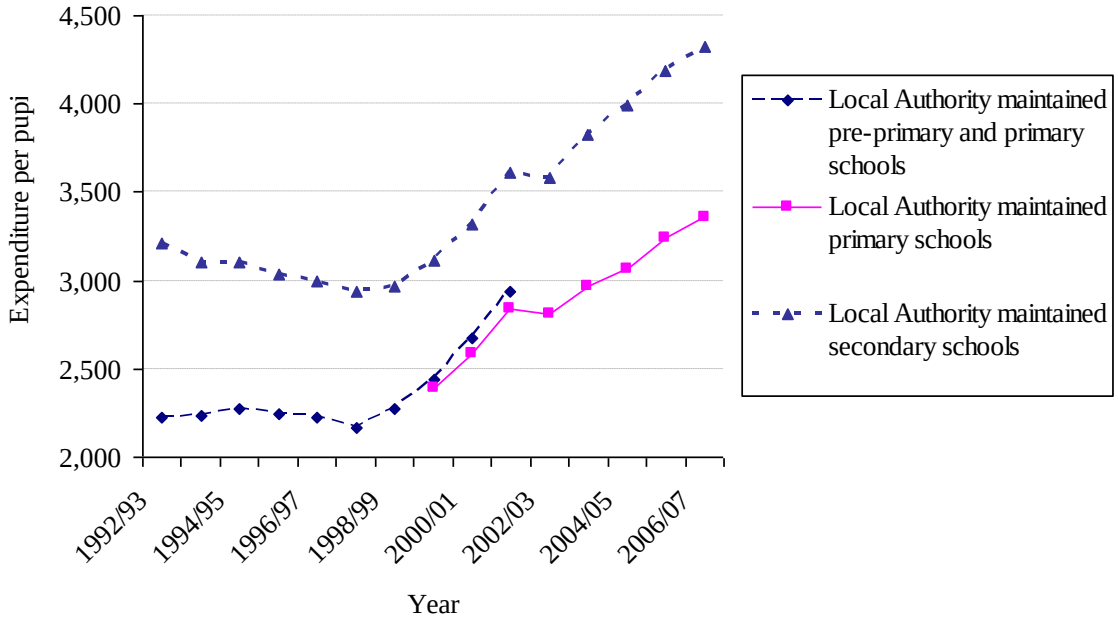
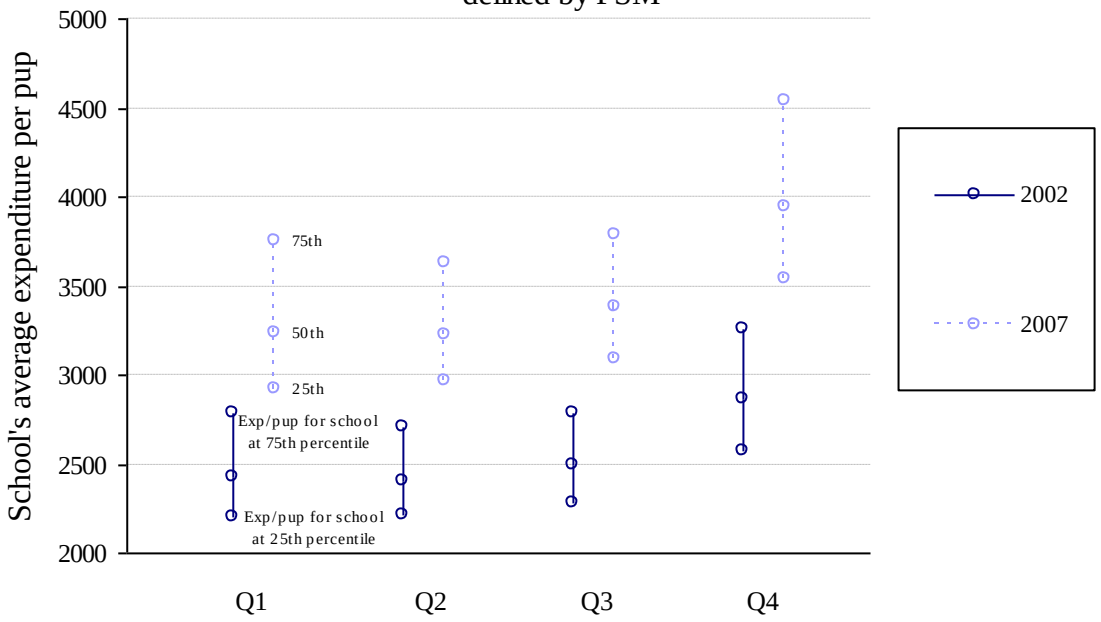


Figure based on official DFES numbers available at
http://www.dcsf.gov.uk/rsgateway/DB/TIM/m002001/index.shtml

Figure 2

Distribution of schools' expenditure per pupil (25th to 75th percentile) in 2002 and 2007 among schools with different degrees of deprivation as defined by FSM



School's level of deprivation

Quartile 1 (least deprived) - Quartile 4 (most deprived)

Deprivation defined based on percentage of pupils eligible for FSM

Table 1

Effects of average expenditure per pupil on Key Stage 2 attainment (national tests at age 11)

	(1)	(2)	(3)	(4)	(5)	(6)
	Point score English		Point score Maths		Point score Science	
Avg. exp/pup	-0.259	0.045	-0.251	0.055	-0.280	0.054
	(0.006)	(0.007)	(0.005)	(0.007)	(0.006)	(0.008)
Observations	3411903	3411903	3411321	3411321	3415527	3415527
Nr of schools	15329	15329	15329	15329	15329	15329
R-squared	0.02	0.65	0.02	0.63	0.02	0.53
Year dummies	x	X	x	x	x	x
School dummies, individual controls		X		x		x

Notes: Standard errors in parentheses; clustered on schools.
Data for KS2 cohorts 2002-2007.
Average expenditure per pupil (over the last three years before KS2 tests) is expressed in thousands of pounds, 2007 prices.
Individual controls include: gender, ethnicity, whether English is a first language (EFL), whether the pupil is known to be eligible for Free School Meals (FSM), Special Educational Needs status (with and without statement), KS1 attainment in Reading, Writing and Maths, and percentage of pupils eligible for free school meals and pupil numbers at school.

Table 2

The effect of expenditure per pupil in individual years on Key Stage 2 attainment -Including future years as a falsification test

	(1) Point score English	(2) Point score Maths	(3) Point score Science
Exp/pup t-2	0.022	0.020	0.013
	(0.004)	(0.004)	(0.005)
Exp/pup t-1	0.012	0.014	0.008
	(0.005)	(0.004)	(0.005)
Exp/pup	0.023	0.018	0.029
	(0.004)	(0.004)	(0.005)
Exp/pup t+1	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
Observations	2828846	2828272	2831877
Number of schools	15049	15049	15049
R-squared	0.65	0.64	0.53
Year dummies, school dummies, individual controls	x	x	x

Notes: Standard errors in parentheses; clustered on schools.
Data for KS2 cohorts 2002-2006.
Expenditure per pupil is expressed in thousands of pounds, 2007 prices.
Individual controls include: gender, ethnicity, whether English is a first language (EFL), whether the pupil is known to be eligible for Free School Meals (FSM), Special Educational Needs status (with and without statement), KS1 attainment in Reading, Writing and Maths, and percentage of pupils eligible for free school meals and pupil numbers at school.

Table 3

The effect of average expenditure per pupil on Key Stage 2 attainment interacted with pupil's Free School Meals (FSM) eligibility status

	(1) Point score English	(2) Point score Maths	(3) Point score Science
Avg. exp/pup	0.036	0.045	0.046
	(0.007)	(0.007)	(0.008)
Avg. exp/pup x FSM eligible	0.027	0.027	0.025
	(0.002)	(0.002)	(0.002)
Observations	3411903	3411321	3415527
Number of schools	15329	15329	15329
R-squared	0.65	0.63	0.53
Year dummies, school dummies, individual controls	X	x	x

Notes: See Table 1

Appendix Table 1

Expenditure per pupil for different spending categories

2002	2003	2004	2005	2006	2007
Expenditure per pupil (Std. Dev) Source: Section 52 Weighted by KS2 pupils as in the pupil-level dataset					
2,539 (471)	2,866 (585)	3,046 (603)	3,132 (587)	3,332 (642)	3,436 (687)
Spending category shares Source: CFR Weighted by KS2 pupils as in the pupil-level dataset					
Teachers					
N.A.	61.2%	61.8%	60.3%	58.8%	N.A.
Support staff					
N.A.	9.9%	10.7%	11.5%	12.5%	N.A.
Other staff					
N.A.	8.6%	8.5%	8.6%	8.7%	N.A.
Building, maintenance					
N.A.	6.6%	6.2%	6.2%	6.4%	N.A.
Learning/IT					
N.A.	5.5%	5.2%	5.4%	5.4%	N.A.
Other					
N.A.	8.1%	7.6%	7.9%	8.1%	N.A.

Notes: Expenditure per pupil refers to real expenditure in 2007 prices.
Expenditure categories correspond to the following CFR classifications: Teachers (E01-E02, E26), Support staff (E03), Other staff (E04-E08), Building/maintenance (E12-E18), Learning/IT (E19-E20), Other (E09-E11, E21-E25, E27-E30).

Appendix Table 2

Summary statistics
Pupil-level dataset, KS2 cohorts 2002-2007

Variable	Mean	Std. Dev.	Observations
Standardized score English	0.00	1.00	3411903
Standardized score Maths	0.00	1.00	3411321
Standardized score Science	0.00	1.00	3415527
(Exp/pup)/1000 – 3-year average	2.85	0.61	3452888
(Exp/pup)/1000 – no average	3.05	0.67	3452888
Male	0.51	0.50	3452888
Eligible for free school meal	0.17	0.37	3452888
Spec. edu. needs without statement	0.20	0.40	3452888
Spec. edu. needs with statement	0.02	0.15	3452888
English as first language	0.90	0.30	3452888
White	0.83	0.37	3452888
Black	0.04	0.19	3452888
Bangladeshi	0.01	0.10	3452888
Indian	0.02	0.15	3452888
Pakistani	0.02	0.15	3452888
Asian_other	0.01	0.11	3452888
Chinese	0.00	0.06	3452888
Mixed	0.02	0.16	3452888
Other ethnicity	0.01	0.11	3452888
Ethnicity unknown	0.01	0.10	3452888
Ethnicity refused	0.01	0.11	3452888
KS1 reading – no level achieved	0.02	0.15	3452888
KS1 reading level 1	0.13	0.34	3452888
KS1 reading level 2A	0.18	0.38	3452888
KS1 reading level 2B	0.20	0.40	3452888
KS1 reading level 2C	0.16	0.36	3452888
KS1 reading level 3	0.27	0.44	3452888
KS1 reading level 4	0.00	0.03	3452888
KS1 writing no level achieved	0.04	0.20	3452888
KS1 writing level 1	0.10	0.30	3452888
KS1 writing level 2A	0.18	0.38	3452888
KS1 writing level 2B	0.28	0.45	3452888
KS1 writing level 2C	0.27	0.44	3452888
KS1 writing level 3	0.09	0.29	3452888
KS1 writing level 4	0.00	0.02	3452888
KS1 maths no level achieved	0.02	0.12	3452888
KS1 maths level 1	0.08	0.27	3452888
KS1 maths level 2A	0.22	0.42	3452888
KS1 maths level 2B	0.21	0.41	3452888
KS1 maths level 2C	0.18	0.38	3452888
KS1 maths level 3	0.24	0.43	3452888
KS1 maths level 4	0.00	0.02	3452888
Pct eligible for Free School Meals (3 year avg. at school)	16.55	14.41	3452888
Log total pupils (3 year avg. at school)	5.68	0.48	3452888