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Deborah A. Cobb-Clark
Nikhil Jha

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Deborah A. Cobb-Clark
MIAESR, University of Melbourne and IZA

Nikhil Jha
MIAESR, University of Melbourne

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IZA

P.O. Box 7240
53072 Bonn
Germany

Phone: +49-228-3894-0
Fax: +49-228-3894-180
E-mail: iza@iza.org

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ABSTRACT

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The school resources – educational outcomes debate has focused almost exclusively on spending levels. We extend this by analysing the relationship between student achievement and schools' budget allocation decisions using panel data. Per-pupil expenditure has only a modest relationship with improvement in students' standardised test scores. However, budget allocation across spending categories matters for student achievement, particularly in grade 7. Ancillary teaching staff seems especially important in primary- and middle-school years. Spending on school leadership – primarily principals – is also linked to faster growth in literacy levels in these grades. On the whole, schools' spending patterns are broadly efficient.

JEL Classification: I21, I22, I28

Keywords: educational achievement, test scores, school resource allocation

Corresponding author:

Nikhil Jha
Melbourne Institute of Applied Economic and Social Research
Level 5, Business and Economics Building
111 Barry Street
The University of Melbourne
Victoria 3010
Australia
E-mail: nikhil.jha@unimelb.edu.au

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1 Introduction

Institutional design and resource management have taken center stage in the ongoing debate about education reform. Policy initiatives are increasingly motivated by a desire to ensure that educational resources are organised, managed, and used effectively so that schools can deliver better outcomes for children. In particular, the link between additional resources (e.g. more per-student expenditure, higher teacher salaries, or smaller class sizes) and improved educational outcomes is, at best, contentious (see Krueger, 2003; Hanushek, 2003, 2006). Without consistent evidence on the efficacy of increased resource levels, interest is growing in finding alternative ways to raise academic achievement. Moreover, the way that education systems are organised, monitored, and managed has clear links to student outcomes (e.g. Bishop, 1997; Fuchs and Woessmann, 2007; Hanushek et al., 2011; Schneeweis, 2011; Schütz et al., 2008; Schtz et al., 2007; Van de Werfhorst and Mijs, 2010). Governments in many countries have therefore moved to provide schools with more autonomy in an effort to make decision-making more responsive to the needs of individual school populations. Finally, there is mounting evidence that what students actually know – as measured by international standardised tests – is important for economic growth and that relatively small improvements in cognitive skill levels can translate into substantial improvements in a population's future well-being (see Fuchs and Woessmann, 2007; Hanushek and Kimko, 2000; Hanushek and Woessmann, 2008, 2011; OECD, 2010). Thus, getting it right can matter a great deal.

This study contributes to this debate by analysing the relationship between student achievement and the allocation of school budgets. To this end, we use unique panel data that link Australian public-school students' standardised test scores to their schools' financial data (i.e., budgets and spending profiles) to estimate value-added models of student achievement. We focus on the state of Victoria where principals have responsibility for developing strategic plans, hiring teachers, and setting budgets which are then endorsed by their individual school councils.[1] The autonomous, decentralised nature of educational decision making in Victoria allows us to assess whether principals' strategic management of resources underpins their schools' educational objectives. In particular, is student achievement growth related to the way that principals allocate their budgets? Are staff salary profiles linked to student test scores? Finally, do schools appear to allocate their resources efficiently?

In addressing these questions, we make two important contributions. First, the debate on school funding has focused almost exclusively on either (i) assessing the equity and adequacy of district-level funding (see Baker and Green, 2008; Downes and Stiefel, 2008) or (ii) understanding the impact of additional funding on educational outcomes (see Krueger, 2003; Hanushek, 2003, 2006; Gibbons et al., 2012, for reviews). While experts have certainly always recognised that how schools spend their money is at least as important as how much money they have to spend (e.g. Hanushek, 1996), it has been nearly impossible to link spending decisions to educational outcomes at either the school or the student level.[2] We are aware of only one other study which, like ours, directly relates individual student achievement to schools' spending patterns. In particular, Nicoletti and Rabe (2012) find that, in the U.K., school-level spending on educational support staff and learning resources helps close the achievement gap between advantaged and disadvantaged students. We extend this literature by analysing whether efficient resource allocation is related to students' achievement growth in an institutional setting in which school principals have a great deal of budget autonomy. Our insights are important in light of current proposals which would see U.S. schools also making more resource allocation decisions (James et al., 2011).

[1]Victorian school councils are legal entities which since 1983 are vested with powers pertaining to the governance of the school.

[2]James et al. (2011) provide evidence that at the school system level achievement is negatively associated with spending on the improvement of instructional services and positively associated with spending on teacher salaries and benefits.

Second, there is a growing literature in economics which assesses the effect of principals on student achievement (e.g. Branch et al., 2012; Clark et al., 2009; Coelli and Green, 2012). This research typically relies on fixed-effects models which are useful in isolating and quantifying principal impacts, but which tell us very little about the mechanisms through which principals influence student achievement. Experts are often left analysing the effect of principals' characteristics, e.g. experience, educational background etc. (Clark et al., 2009) or leadership style (Grissom and Loeb, 2011) in an effort to better understand why principals matter. Others have linked the amount of time principals spend in "organisational management" (i.e. managing budgets and resources, hiring personnel and managing school facilities) to student achievement growth and positive assessments of the instructional climate by teachers and parents (Horng et al., 2009). Similarly, Branch et al. (2012) have linked principal effectiveness to teacher hiring and turnover, concluding that principals may affect outcomes by managing teacher quality. We extend this literature by moving beyond a simple analysis of principals' skill or time inputs into the education production function to consider the educational consequences of their strategic spending decisions.

We find that, consistent with much of the existing literature, additional per-pupil expenditure has a modest relationship with improvement in students' standardised test scores. At the same time, the way that budgets are allocated across spending categories matters for student achievement, particularly with respect to outcomes in grade 7. Ancillary teaching staff seem especially important in promoting achievement growth in numeracy and reading in primary- and middle-school years. Spending on school leadership – primarily principals – is also linked to faster growth in literacy levels in these same grades. On the whole, however, it appears that decentralised decision making by Victorian principals has resulting in spending patterns that are broadly efficient.

This paper is organised as follows. In Section 2, we begin by discussing the institutional context in which Victorian principals are operating. Section 3 outlines our value-added estimation framework while our data are described in detail in Section 4. Results are then presented in Section 5 and conclusions can be found in Section 6.

2 Decision Making in Victorian Schools

Education in Australia is managed at the state (or territory) level.[3] We focus our analysis on public primary- and secondary-school students in the state of Victoria. This is the second largest school system in Australia both in terms of number of schools and number of students.[4] Public schools represent approximately 68 percent of all schools in Victoria, educating approximately 63 percent of all full-time students (DEECD, 2011c).

Although most public schools in Australia have substantial autonomy, this is true even more so in Victoria which began decentralisation in the late 1960's. Unlike U.S. states which delegate decision-making authority to local school districts, decentralisation in Victoria resulted in a state-to-site funding model in which state funds are allocated directly to individual schools. The Education Act (School Councils Act) of 1975 created school council as legal entities and in 1983 school councils were vested with powers pertaining to the governance of the school.[5] Council powers were subsequently enhanced so that, by 1992, school councils had substantial autonomy to determine school policy and allocate budgets (Odden and Busch, 1998, Ch. 4). Since then, however, there has been a move toward increasing the responsibility of principals – who have clear goals and accountability – in managing schools.

Today, the management of Victorian school operations is categorically de-

[3]Australia has six states and two territories. Each effectively functions as a separate school district.

[4]Victoria has approximately 1489 schools (including special schools and language schools) and 530,821 students in the public-school system (DEECD, 2011c).

[5]The recommended size of school council is between 6 and 15 members including parents, education department representatives, the principal (who is an ex- officio member), and community members. Council members are elected for two years and elections are held annually.

fined to be the role of principals. Principals lead the development of strategic plans, allocate budgets and implement policies. School councils mainly have oversight responsibilities which include assisting in strategic planning, approving annual budgets, and monitoring expenditure.[6] Consistent with their goal of supporting principals to ensure efficient school governance, school councils continue to be vested with power to enter into contracts, employ teachers on short-term contracts, charge fees to parents for goods and services provided by the school, and carry out construction (DEECD, 2009, 2010). Finally, school councils provide feedback on principal performance to the education department. The responsibility for renewing a principal's contract, however, rests with the regional director–a Victorian Department of Education and Early Childhood Development (DEECD) official–who takes into account the principal's performance against the benchmarks set in his or her contract and/or annual performance review. School councils also recommend candidates to fill vacant principal positions (DEECD, 2010).

Victorian principals' financial management of their schools' budget is monitored in several ways. In particular, all principals must prepare an annual report including a summary of the school's financial performance and financial position. This summary must be consistent with school's operating statement, balance sheet and financial commitments summary, all of which are certified by the principal and school council president (DEECD, 2011b). The annual report is then submitted to DEECD's regional office and presented to the school community at a public meeting.[7]

[6]For example, community members may be nominated for their expertise in finance (DEECD, 2010).

[7]This is required to meet a condition of registration under the Education and Training Reform Regulations (2007), and to ensure compliance with the Financial Management Act (2004) and Victoria's funding agreements with the Commonwealth.

3 Method

Our estimation strategy relies upon a production function framework in which the output is a measure of educational achievement and school resources (i.e. per-pupil expenditure) are taken to be one of the inputs. Education is a cumulative process which implies that student achievement will be a function of investments made in previous periods (Boardman and Murnane, 1979; Todd and Wolpin, 2003). Like others in the literature we assume that the effects of all previous inputs decline geometrically at the same rate over time leading to a value-added specification of the production function (see Hanushek et al., 2009; Harris, 2010, for details).[8] In particular, we estimate the following value-added specification:

$$A_{igst} = \phi A_{i(g-2)(s-2)(t-2)} + \mathbf{X}_{igst}\,\boldsymbol{\alpha} + \mathbf{S}_{(g)st}\,\boldsymbol{\beta} + \mathbf{E}_{st}\,\boldsymbol{\theta} + \epsilon_{igst} \qquad (1)$$

where A_{igst} is an achievement measure for a student i in school s in grade g at time t. As standardised testing is conducted for alternate grades in Australia (specifically in grades 3, 5, 7, and 9) we consider achievement growth over a two-year period. Thus, $A_{i(g-2)(s-2)(t-2)}$ denotes the achievement score of student i in the previously-tested grade level $(g-2)$ at the school $(s-2)$ two years earlier. Detailed information about the funding of schools, our data sources and variable construction are provided in Section 4.

In the above specification, X captures students' demographic characteristics and family backgrounds. Family background characteristics are particularly important in controlling for those educational resources available to children at home that may affect achievement growth. Information about schools' student body composition, location, size and type is included in S in order to account for school-level factors affecting student achievement.

Our objective is to assess the effect of school expenditure (E) on educational

[8] The value added model has several other assumptions, not all of which are innocuous. See Harris et al. (2010) for details.

achievement. We consider two models. First, school expenditure is measured by total per-pupil expenditure. Here θ captures the disparity in schools' educational attainment that is explained by the variation in schools' available resources as reflected in per-pupil spending. This model is consistent with the large literature which analyses the effect of additional funding on educational outcomes (Krueger, 2003; Hanushek, 2003, 2006; Gibbons et al., 2012). Second, total per-pupil expenditure is replaced by a vector that captures per-pupil expenditure in five different spending categories. The vector of coefficients, θ, is then informative about the efficiency of school spending decisions across Victorian schools. In particular, if resources are allocated efficiently in aggregate we would expect that the marginal effect of a dollar spent on achievement growth would be equal across spending categories.

The specification of the error term (ϵ_{igst}) is important for understanding the assumptions necessary to achieve causal identification of θ (the coefficient of interest) and the other parameters in the model. Despite the many detailed student- and school-level controls included in the analysis (see Section 4), it remains possible that unobserved factors may be correlated with both educational achievement and schools' spending patterns leading our estimates to be biased. There is a great deal of ambiguity and disagreement about the appropriate way to account for unobserved heterogeneity (Hanushek et al., 2009). Many researchers turn to the inclusion of student-, grade- or school-level fixed effects as a convenient way of eliminating the effects of unobserved, time-invariant factors. The interpretation of the resulting estimates, however, depends on the combination of fixed effects included, i.e. on the source of identifying variation (Harris, 2010). The data almost never permit all fixed effects (and their interactions) to be included simultaneously. Thus, researchers must make judgement calls about the specification that uses their data most effectively to best answer the particular question at hand.

In our case, we are particularly concerned about the potential for unobserved, student-level heterogeneity related to school spending to bias our results. Specifically, parents may be choosing schools on the on the basis of school resources and spending patterns (Rivkin, 2007). Alternatively, parents and schools may target resources to students with particular needs (Gibbons et al., 2012). By controlling for lagged educational achievement, the value-added specification given above takes an important step forward in accounting for the effects of unobserved, student-specific heterogeneity associated with family background, ability, etc. (Harris, 2010). At the same time, the estimation error in equation (1) will implicitly also include any lagged achievement error (see Hanushek et al., 2009; Meghir and Rivkin, 2011; Harris, 2010). If educational achievement is a function of unobserved, time-invariant, student-specific effects both the lagged and contemporaneous achievement error will be correlated with lagged achievement leading to biased estimates.[9] To deal with this, Nicoletti and Rabe (2012) propose a two-step estimation method which uses contemporaneous and lagged achievement tests across several domains to estimate a student-level fixed effects model. This allows them to control for any student-specific effect that is invariant across those domains. In a similar spirit, we include measures of lagged achievement across multiple domains in $A_{i(g-2)(s-2)(t-2)}$.

We are also concerned about the potential for school-level effects to confound interpretation of our estimates. Schools that have financially savvy school councils, for example, may be able to employ (or retain) principals that are more effective both in the financial management of the school as well in positively affecting educational outcomes. Bloom et al. (2012), for example, find that – across countries – better management practices within schools are associated with better educational outcomes. The inclusion of the parental educational and occupational profile of students goes some ways towards addressing this concern. However, there may be unobserved heterogeneity in parents' involve-

[9] Harris (2010) discusses and provides evidence on the alternative assumptions necessary to achieve unbiased estimation in this case.

ment with the school that is not fully captured by these variables. Similarly, although we account for changes in principals across time, we have no other information about principals' that would allow us to account for heterogeneity in their ability, leadership style, or effectiveness. Consequently, we include school fixed effects in the model to account for all remaining time-invariant, school- and principal-specific characteristics. Our estimates are then based on variation within schools across time, ignoring any variation in spending patterns across schools.[10] This choice implies that we will be assessing whether changes over time in the way that a school allocates its resources can be linked to growth in its students' achievement.

We therefore allow for the following error structure in our estimation:

$$\epsilon_{igst} = \gamma_t + \gamma_s + \eta_{igst} \tag{2}$$

In the equation above, γ_t is a vector of time dummies which control for achievement differences that are common to students tested at the same time.[11] School fixed effects are given by γ_s. The final term, η_{igst}, includes all other unobserved effects as well as random noise.

4 Data

Our analysis rests on unique panel data for 2008 - 2011 that link students' standardised test scores to (i) previous test scores; (ii) their own characteristics; (iii) their schools' characteristics; and (iv) their schools' financial information. The estimation sample is drawn from two cohorts of students for whom we have repeated achievement data: (i) those taking achievement tests in 2008 and 2010; and (ii) those taking achievement tests in 2009 and 2011. Together, these data allow us to analysing the relationship between student achievement growth and

[10] Of the total variance in per-pupil expenditure, 21 percent occurs within schools over time. The proportion of within-school variance in other expenditure categories is similar.

[11] Grade fixed effects are redundant since our analysis is done separately for each grade.

principals' allocation of school budgets.

4.1 Test Scores

Standardised achievement tests were introduced across all Australian schools in 2008. National Assessment Program - Literacy and Numeracy (NAPLAN) tests are administered to all students in grades 3, 5, 7 and 9 in each of the following 5 domains: reading, writing, language (spelling, grammar and punctuation) and numeracy. Scores are subject-specific, vertically scaled to allow for comparison across grades, and comparable across time (within subject) so that the educational achievement represented by a particular score does not change over time. Scores range from 0 to 1000 but were standardised in 2008 by domain to have a mean of 500 and standard deviation of 100.[12] Each single-year grade progression represents an increase of approximately 25 points on the scale (or 50 points across NAPLAN testing grades).[13] Our focus is on numeracy, reading and writing outcomes. Mean NAPLAN scores (and standard deviations) are provided in Table 1 by grade and year.

With two exceptions, mean achievement scores are significantly different across subsequent years in all grades and domains. Moreover, across the sample period achievement scores in younger grades can vary within a fairly wide range, particularly in numeracy.[14] Two consistent pattern emerge: (i) mean achievement scores increased in all domains in 2010 when compared to 2009; and (ii) there is a decline in mean numeracy scores in the year 2011 across all grades when compared with 2010.

[12] We use the 2008 national mean and standard deviation by grade and domain to standardise scores across all years in our data.

[13] See Analysing NAPLAN Data at www.vcaa.vic.edu.au/Documents/naplan/analysingnaplan data.pdf (retrieved on Oct 13, 2012).

[14] The 22.32 point difference in numeracy between 2008 and 2010 represents nearly one year of grade progression.

4.2 Funding Allocation Rules and School Spending Measures

Since 2005, Victorian public schools have been allocated funds on the basis of a funding model referred to as the Student Resource Package (SRP). The SRP is composed of (i) student-based funding; (ii) school-based funding; and (iii) targeted initiatives. Student-based funding provides the major source of revenue and varies by grade-level as well as by school-level student, family and community characteristics. Per-pupil funding is higher in schools that are smaller, are more rural, or provide education for more disadvantaged students. In particular, schools with a high concentration of disadvantaged students (as measured by parental occupation and education), higher student mobility, or more students with English as a second language attract additional funds. School-based funds provide for school infrastructure and are school-specific, while targeted initiatives provide funds for programs with specific targeting criterion.[15] Although the SRP provides the vast majority of funding, schools may have also other sources of funds including parent contributions, donations, local fund-raising and trading operations (via canteens, out-of-hours child care, book sales, etc), or bank interest (for details, see DEECD, 2011a). As the majority of funds are allocated on a per-student basis, school enrollment is a very important determinant of the total funds available to each school.

Victorian principals are supported in their budget management by software called CASES21 (Computerised Administrative System Environment in Schools) through which both record keeping and reporting is done. It is from this system that the financial data for each school are drawn. Per-pupil SRP expenditure can be classified into one of five expenditure categories: (i) leadership and management; (ii) expert teachers; (iii) inexperienced teachers; (iv) ancillary teaching staff, e.g. music or arts teachers, expenditure on supervision of student teachers, or specialist language staff; and (v) non-teaching items. Given the variable na-

[15]See DEECD (2012) for details.

ture of non-SRP funding and the fact that CASES21 does not record how schools are spending their non-SRP funds, we choose to focus on SRP based per-pupil expenditure.[16] In particular, we believe that schools are unlikely to be hiring additional classroom teachers or senior executives on the basis of non-SRP funds which cannot be assured in the future. Therefore, our choice to focus on structured funds available to schools will exploit economically meaningful variation in expenditure that directly impacts student academic achievement.

Any potential mismatch in the timing of expenditure and observation of standardised test scores raises important concerns. First, as the school expenditure data are annual while standardised tests are administered in May of each year, timing differences may confound the effect of expenditure on test results.[17] A second concern is the possibility that attenuation bias will occur due to measurement error in schools' expenditure data. We use a measure of annual per-pupil expenditure averaged over two years to deal with both concerns. Specifically, our measure of expenditure (E_{st}) is given by:

$$E_{st} = (0.5 * Expd_{st} + Expd_{st-1} + 0.5 * Expd_{st-2})/2 \tag{3}$$

where $Expd_{st}$ is the per-pupil SRP expenditure in year t and $Expd_{st-1}$ and $Expd_{st-2}$ are defined equivalently. The weights in equation (3) reflect the timing of testing and our value-added specification. Averaging in this way is expected to reduce measurement error, albeit at the cost of a loss in precision due to the decrease in within-school variation.

In order to minimise the effects of outliers, our analysis excludes schools with expenditure in the top 1 percent of the within-category (i.e. primary- or

[16] Non-SRP expenditure would also reflect change in schools' finances due to cashing in of long-service leaves, sick leave, maternity leave in addition to the local fund-raising and trading operations mentioned above.

[17] A generalised value-added model that follows from a cumulative production function framework captures the effect of prior inputs through the inclusion of prior test scores. However, as standardised tests are administered in alternate grades in Australia, this is not sufficient to capture the effect of expenditure in the penultimate year of the test.

secondary-school) expenditure distribution. We lose a total of 40 schools (1440 observations) from a sample of over 1300 schools. These schools are generally much smaller and spend, on average, almost twice as much per student.

The Victorian funding model described above is an excellent setting in which to assess how the allocation of funds across different spending categories affects educational achievement. Our focus on public schools is also important in that–unlike in the private school sector–the same funding rules apply to all schools, conditional on enrollment and student composition. Thus, we are able to control for the process generating variation in per-pupil expenditure in order to focus explicitly on the allocation of that per-pupil expenditure.

Table 2 provides summary statistics for our key spending measures separately for primary and secondary schools.[18] On average, Student Resource Package (SRP) based per-pupil expenditure (2-year average) is $5,678 AUD and $7,385 AUD for primary and secondary schools, respectively. Secondary schools are generally much larger (mean enrollment size of 790 students) than are primary schools (mean enrollment size of 275 students). The smallest primary school in our sample has an enrollment size of 22 students and the smallest secondary school has 98 students enrolled. School size is an important source of variation for our analysis. Nonetheless, our results are robust to exclusion of small schools.[19] Some schools in our sample may not allocate any expenditure in a particular category in a particular year. This is more likely in primary schools which are generally smaller. Expenditure shares, however, are similar across categories in both primary and secondary schools. Each spend approximately 33 percent of their budgets on expert teachers—their largest share of the expenditure. Non-teaching expenditure accounts for approximately 25 percent of the budget.

[18]The table excludes schools with 2-year average per-pupil expenditure greater than the 99^{th} percentile as described above.

[19]Results available on request.

4.3 Other Controls

Information on student- and school-level characteristics comes from each school's administrative data. Time-invariant indicators of students' gender, Aboriginal/Torres Strait Islander status, language background (i.e. whether or not a language other than English is spoken at home) are recorded at the time of enrollment. Students' family background information including parental occupation and education are updated regularly through two annual school censuses. As funding is linked to the socio-economic profile of each school's student body, this information is likely to be highly accurate. Parental occupation is classified into six occupational groups, while parental education is classified into five categories (see Table A.2). Our analysis includes separate indicator variables for each of these.

We also include a range of school-level characteristics. To account for student body profiles which vary over time, we use the school's administrative data to construct measures of the proportion of students that are (i) female; (ii) Aboriginal/Torres Strait Islander; and (iii) native-English speakers. These proportions vary by school, year, and grade level. In addition, we include an indicator for schools that had no change in their principal at any point in our data period (2008-2011). School fixed effects account for the school's geographic location and school type–i.e., primary (grade 6 and below) or secondary (grade 7 and above).[20] Finally, all our estimation models include a quadratic in the log of annual enrollment to account for school size.[21] Summary statistics for the student- and school-level variables included in our analysis are reported in Table A.1.

[20]A small number of students (less than 5 percent) attend combination primary-secondary schools. In terms of enrollment these schools are comparable to secondary schools. We, therefore, consider them jointly with secondary schools.

[21]Figures 1 through Figure 4 suggest that the relationship between numeracy achievement and a quadratic in the log of school size across grades is approximately linear. The relationship is similar for other domains. In preliminary analysis, we also estimated all models on a sample which excluded schools with very low enrollments. We found the estimates to be nearly identical and have therefore reported the results for the full sample.

5 Results

5.1 Total Per-pupil Expenditure

The estimated effect of per-pupil expenditure on the growth in student achievement is shown in Table 3. The results reflect the marginal effect of an additional \$1000AUD in per-pupil expenditure on the growth (measured in std.) in students' achievement test scores.

We find that additional per-student expenditure results in larger gains in student achievement in grade 9 numeracy (0.05 std.) and in grade 5 writing (0.08 std.). While substantial, the imprecision commonly associated with fixed-effects estimation results in large errors and neither effect reaches statistical significance at conventional levels.[22] In almost all other cases, expenditure is not related to student achievement growth either statistically or economically. The exception is that additional spending results in significantly smaller gains in reading achievement (0.02 std.) as young people transition from primary to secondary school. This is somewhat puzzling and may indicate that some endogenous targeting of resources towards students with the greatest need remains despite our extensive controls (see Gibbons et al., 2012).

The effect of school resources on improvements in Victorian students' achievement is similar in magnitude to that found in the U.S. and the U.K.[23] In particular, Nicoletti and Rabe (2012) find that in U.K. secondary schools an additional £1000 in per-pupil expenditure results in an increase in achievement growth of between 0.04 std. (numeracy) and 0.03 std. (English). Similarly, Gibbons et al. (2012) find that primary-school student achievement increases by 0.01 std. with each additional £400 in per-pupil expenditure. As we do here, these authors

[22]Results are more precisely estimated when we use single-year expenditure rather than expenditure averaged over two years because we can exploit more of the within-school time variation in our data. Despite this, we have chosen to present estimates based average expenditure because this (i) reduces the potential for measurement error to lead to reversion to the mean (Nicoletti and Rabe, 2012); and (ii) allows us to more sensibly align the timing of expenditure with student outcomes.

[23]For reviews of this literature see Gibbons et al. (2012) and Hanushek (2010).

also control for lagged achievement and school-level fixed effects. In contrast, Greenwald et. al. (1996) conducts a meta-analysis of the entire U.S. school resources literature and concludes that, across all studies, an increase of $500US in per-pupil spending is linked to substantially higher (0.15 std.) student achievement.[24]

On balance, our results suggest that it is best to be cautious about the potential for increased funding levels to lift student achievement.[25] As Hanushek (2010) argues, it is not that schools' resources never matter, but rather that there does not seem to be any systematic relationship between resources and educational outcomes. This conclusion is also highlighted in the analysis of schools in England by Machin et al. (2010), who find considerable heterogeneity in the impact that resources have on schools with additional resources mattering more for poorer schools.

5.2 Disaggregated Expenditure

We turn now to consider the differential effect of per-pupil spending across each of our five alternative expenditure subcategories (see Section 4.2). Results are presented in Table 4 for numeracy, Table 5 for reading, and Table 6 for writing. As before, results can be interpreted as the marginal effect of an additional $1000AUD in per-pupil spending on the growth (measured in std.) in student achievement.

Our results indicate that there is often a differential impact of per-pupil spending that occurs in one category relative to others. For example, additional expenditure on ancillary teaching staff results in significantly larger gains in numeracy achievement as students begin secondary school (grades 5 to 7) (see Table 4). Expenditure on inexperienced teachers and non-teaching related items

[24]By conducting our analysis within a single school district, we avoid the positive bias that occurs when favorable district- or state-level educational policies are correlated with higher resources (Hanushek, 2003). Thus, we generally expect our estimates to be lower than corresponding inter-district estimates in the literature.

[25]For more on this debate in the literature see Krueger (2003); Hanushek (2003, 2006).

has the opposite effect. Substantial gains in primary-schoool (grades 3 - 5) numeracy achievement are also closely linked to additional expenditure on ancillary teaching staff, though the effect is not quite significant at the 10 percent level.

Previous evidence suggests that numeracy test scores are more sensitive to principals' and teachers' actions than are English test scores (Clark et al., 2009; Rockoff, 2004; Rivkin et al., 2005; Kane et al., 2008).[26] Interestingly, however, we do not find that the link between expenditure and reading or writing achievement is on the whole weaker than it is with respect to achievement in numeracy. This is particularly true in primary schools where substantial gains in student literacy between grades 3 and 5 are linked to additional expenditure on ancillary teachers (0.38 std. reading) and expert teachers (0.22 std. writing). Expenditure on ancillary teachers is also associated with significantly larger gains in reading scores as young people enter secondary school (grades 5 to 7).

There is also evidence that expenditure on leadership and management personnel (including principals) results in faster growth in grade 5 writing skills (0.18 std.) and grade 7 reading levels (0.05 std.). This is consistent with the large literature demonstrating the importance of principals in delivering good educational outcomes by effectively managing schools (e.g. Horng et al., 2009) and attracting and retaining good teachers (e.g. Beteille et al., 2009; Branch et al., 2012). Much of this literature is based on models which use school-fixed effects and leadership changes to isolate the effects of individual principals. Without disaggregated expenditure data, however, researchers have been unable to explicitly consider the tradeoffs inherent in spending additional resources on school management. In short, concluding that good principals matter is not the same thing as concluding that it is effective to spend more money on principals, especially since that may result in reduced expenditure in other areas. Our results indicate that expenditure on principals can indeed be linked to improved literacy achievement – particularly for younger students.

[26] See Clark et al. (2009) and reference cited therein.

It is difficult to put these results in context because very few studies explicitly consider the differential effects of spending school resources in alternative ways. Those that do, however, confirm our finding that the composition of school expenditure matters. James et al. (2011), for example, conclude that school-level achievement is higher when schools spend more on teacher salaries and less on instructional services. Similarly, Nicoletti and Rabe (2012) find that spending on classroom teachers is linked to higher test scores, while spending on substitute teachers is related to lower test scores. Moreover, these authors find that impact of additional resources varies across the distribution of student ability.

What do our results imply about the efficiency of schools' spending patterns? Could better outcomes be achieved if school resources were expended in a different way? We address these questions by conducting a series of standard F-tests to determine the joint equality of our estimated marginal effects. We first test whether or not the effect of per-pupil expenditure is jointly equal across all five spending subcategories. If schools are on average allocating their resources in a way that maximises students' test scores, we would expect that the impact of an additional $1000 AUD of per-pupil expenditure would be approximately the same no matter how it was spent. Results are presented in the first panel of Table 7. Second, we consider the efficiency of spending across the staff profile. Specifically, we test whether or not the effects of spending on experienced, inexperienced, and ancillary teachers are jointly equal (see panel 2). These tests are based on the estimation results presented in Tables 4 - 6.

We fail to reject the null hypothesis that the marginal effect of per-pupil spending is equal across all spending categories in all but two cases. On the whole, it appears that in the Victorian context decentralised decision making by school principals has resulted in spending patterns that are largely efficient. At the same time, we reject equality in the case of grade 7 numeracy achievement. The results in Table 4 indicate that students' numeracy scores could be improved if resources were diverted from spending on inexperienced classroom teachers and non-teaching items into spending on ancillary teachers. Similarly, grade 7 reading achievement growth could be improved if schools increased their expenditure on ancillary teaching staff and reduced it in other teaching and non-teaching categories (see Table 5). These results are confirmed when we explicitly consider the efficiency of the way that expenditure is allocated across the teaching staff profile. We reject the null hypothesis that the marginal effect of per-pupil expenditure is the same for experienced, inexperienced, and ancillary teachers. Instead, we find that numeracy and reading achievement growth in grades 7 and 5 in Victorian schools could be improved by increasing spending on ancillary teachers and reducing it elsewhere (see Tables 4 and 5).

Finally, we test the hypothesis that the effect of spending on school leadership and management is equal to that of spending on teaching staff. To do this, we aggregate expenditure on experienced, inexperienced, and ancillary teachers and re-estimate our model with three expenditure subcategories: (i) leadership and management; (ii) teaching staff; and (iii) non-teaching items. We then test whether the marginal effect of expenditure on school leadership and management is equal to the marginal effect of expenditure on teachers. The results are presented in panel 3 of Table 7. We reject the null hypothesis that the marginal effect of additional spending on school leadership is equal to that of additional spending on teachers in the case of grade 7 numeracy and reading achievement. In these two instances, achievement growth could be improved by increasing expenditure on school leaders including principals and reducing expenditure on teaching staff and non-teaching supplies like books and computers.[27]

[27] Using three spending subcategories, we find that additional spending on school leadership and management significantly increases achievement growth in grade 7 numeracy (0.05 std.) and reading (0.06 std.). In contrast, additional spending on teachers and non-teaching items has an insignificant negative or essentially zero effect on student achievement. Results available upon request.

6 Conclusions

It seems likely that institutional design and resource management will continue to factor heavily into the ongoing debate about educational reform. Policy makers are taking interest in evidence that – in well-developed educational systems with appropriate accountability – school autonomy can be linked to better outcomes (Hanushek et al., 2011). In the United States, for example, there are calls to link schools' financial systems to student learning in order to help decision makers understand what works (Gazzerro and Laird, 2008).

This study contributes to this debate by analysing the relationship between student achievement and the allocation of school budgets in an institutional context in which principals have responsibility for developing strategic plans, hiring teachers, and setting budgets. Specifically, we use unique data linking Australian students' standardised test scores to their schools' financial data to estimate the effect of school expenditure patterns on the growth in student achievement.

Our results are important in highlighting that the way schools allocate their budgets matters for their students' educational achievement, particularly with respect to achievement growth between grades 5 and 7. Spending on ancillary teaching staff seems especially important in promoting achievement growth in numeracy and reading in primary- (grade 5) and middle-school (grade 7) years. Similarly, per-pupil expenditure on school leadership – primarily principals – is also linked to faster growth in literacy levels in these same years. Across Victorian schools as a whole, it appears that the autonomous decisions of thousands of school principals have resulted in a resource allocation that is broadly efficient.

Together these results lend weight to calls for educational reforms which provide incentives for decision makers – in our case school principals – to manage their resources well (see Hanushek, 2003, 2006). Victorian principals have a great deal of latitude in their decision making and it is this flexibility that may underlie our finding that across the Victorian system as a whole, resource allocation is broadly efficient. James et al. (2011), for example, have argued that the lack of flexibility among U.S. principals has led to a great deal of inefficient spending. On balance, our results support political initiatives to give schools greater flexibility in resource allocation.

At the same time, it is important to note that Victorian principals' spending decisions are closely monitored by Education Department staff. The same administrative data system that allows us to link spending patterns to students' achievement test scores allows DEECD to monitor schools' financial accounts, audit results, spending patterns etc. and assign a "score" for financial management to each school annually. Moreover, Victorian school principals are publicly accountable for their spending decisions to their individual school council and to the school community as a whole. Thus, it is likely that sensible management and accountability systems in Victoria have been helped to limit the potential for individual principals to act opportunistically (see Wößmann, 2005).

Finally, the previous evidence is clear that principals and teachers are important inputs into the production of student achievement (see for example Clark et al., 2009; Rivkin et al., 2005; Branch et al., 2012). It is less clear, however, how spending on teachers, principals, and indeed other inputs should be allocated when budgets are fixed. Our results suggest that if the goal is to improve literacy and numeracy levels more – not less – should be spent on school leadership and management in middle-school years.

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Tables

Table 1: **Test Scores (NAPLAN): Grade - Year**

Year	Numeracy Mean	Numeracy Std. Dev	Numeracy t-stat*	Read Mean	Read Std. Dev	Read t-stat*	Writing Mean	Writing Std. Dev	Writing t-stat*
				Grade 9					
2010	584.63	66.55		574.22	64.29		567.02	89.21	
			[-3.6725]			[5.4742]			[-0.6833]†
2011	582.27	66.88		577.59	63.48		566.43	91.66	
				Grade 7					
2008	544.38	68.42		534.35	66.27		538.07	80.47	
			[-4.3752]			[5.2478]			[-9.7200]
2009	541.65	65.95		537.59	66.85		530.97	76.34	
			[7.3291]			[4.0958]			[6.0282]
2010	547.10	70.99		545.51	67.03		531.33	76.30	
			[-6.3126]			[-17.4325]			[-0.9840]†
2011	545.27	71.02		538.01	64.59		522.51	77.26	
				Grade 5					
2008	484.10	69.38		488.65	74.69		493.29	74.49	
			[13.8358]			[15.1047]			[-4.5102]
2009	492.97	67.46		499.36	77.02		490.28	67.55	
			[6.6117]			[-4.1694]			[9.0525]
2010	506.42	71.35		503.14	76.71		496.82	66.16	
			[-25.5764]			[-8.0345]			[-8.6637]
2011	503.19	70.67		506.87	77.31		494.33	65.01	
				Grade 3					
2008	418.91	71.78		419.47	81.05		424.02	67.62	
			[-8.3629]			[18.0685]			[4.6657]
2009	413.89	77.31		431.78	88.43		426.48	62.87	

*: t-statistics is based on one-sided t-tests (equal variance) of whether change in tests between subsequent years is significantly different at 0.01 percent. All test score changes across years are significant except as denoted by †.

Table 2: **Enrollment and Avgerage (2-year) Expenditure Summary**

Variable	Mean	Std. Dev.	Min.	Max.
	Primary Schools			
Enrollment	275.56	187.93	22	1786
Per-Pupil Expenditure (SRP)†	5678.09	1001.37	4080.53	10904.56
Expd. on Leadership	1048.58	466.12	368.65	3780.04
Expd. on Expert Teachers	1864.01	722.47	0	5115.71
Expd. on Inexperienced Teachers	1291.53	574.24	0	3738.59
Expd. on Ancillary Teaching	21.62	115.7	0	1486.99
Expd. on Non-teaching	1452.34	401.25	799.18	4161.5
	N		1035	
	Secondary Schools			
Enrollment	790.1	454.54	98.8	2380.9
Per-Pupil Expenditure (SRP)†	7385.81	1511.21	4696.81	12592.69
Expd. on Leadership	1372.53	482.8	542.85	3531.07
Expd. on Expert Teachers	2445.96	740.88	623.6	5491.77
Expd. on Inexperienced Teachers	1607.67	555.39	519.61	3543.85
Expd. on Ancillary Teaching	99.73	162.22	0	1260.44
Expd. on Non-teaching	1862.79	472.68	1105.04	3966.88
	N		235	

Statistics are based on school-level data pooled across 2008 through 2011.

All Expenditure (Expd.) categories by per pupil and in AU $'s.

‡:Student Resource Package (SRP) is the primary source of funding of schools.

Table 3: **2 year Avg. SRP Per Pupil Expenditure**

	Grade 9-7	Grade 7-5	Grade 5-3
Numeracy	0.046	-0.013	-0.017
	(0.051)	(0.010)	(0.068)
Read	0.015	-0.022**	0.016
	(0.053)	(0.010)	(0.067)
Write	0.000	0.004	0.081
	(0.101)	(0.014)	(0.066)
Observations†	42,642	43,502	58,223
School FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors (in parentheses) adjusted for clustering at school level.

†: For Numeracy; Number of observations for Reading and Writing differ marginally.

*** p<0.01, ** p<0.05, * p<0.10

Table 4: **Numeracy Achievement and 2 year Avg. School Resource Allocation**

	Grade 9-7	Grade 7-5	Grade 5-3
log (Enrollment)	-2.528	-0.398*	0.158
	(1.918)	(0.217)	(1.669)
log $(\text{Enrollment})^2$	0.208	0.031*	-0.054
	(0.008)	(0.145)	(0.150)
Expd†. Leadership	0.054	0.027	0.081
	(0.105)	(0.027)	(0.161)
Expd. Expert	-0.000	-0.027	-0.001
	(0.074)	(0.019)	(0.114)
Expd. Inexperienced	0.018	-0.053**	0.134
	(0.090)	(0.023)	(0.127)
Expd. Ancillary Teaching	0.049	0.081***	0.220
	(0.280)	(0.023)	(0.136)
Expd. Non-teaching	0.099	-0.102***	-0.074
	(0.116)	(0.021)	(0.104)
Observations	42,642	43,502	58,223
School FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 5: **Read Achievement and 2 year Avg. School Resource Allocation**

	Grade 9-7	Grade 7-5	Grade 5-3
log (Enrollment)	-1.263	0.230	0.488
	(1.648)	(0.239)	(1.355)
log (Enrollment)^2	0.076	-0.019	-0.073
	(0.006)	(0.124)	(0.122)
Expd†. Leadership	-0.054	0.051*	0.136
	(0.117)	(0.028)	(0.144)
Expd. Expert	-0.076	-0.013	-0.027
	(0.088)	(0.019)	(0.109)
Expd. Inexperienced	0.036	-0.028	0.059
	(0.094)	(0.023)	(0.126)
Expd. Ancillary Teaching	0.027	0.050*	0.384***
	(0.317)	(0.028)	(0.130)
Expd. Non-teaching	0.109	-0.029	0.003
	(0.105)	(0.023)	(0.088)
Observations	42,631	43,531	58,374
School FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.10

Table 6: **Write Achievement and 2 year Avg. School Resource Allocation**

	Grade 9-7	Grade 7-5	Grade 5-3
log (Enrollment)	-1.037	-0.214	-0.020
	(2.949)	(0.280)	(0.974)
log $(\text{Enrollment})^2$	0.080	0.017	0.010
	(0.222)	(0.021)	(0.087)
Expd†. Leadership	0.190	-0.020	0.178
	(0.197)	(0.036)	(0.116)
Expd. Expert	0.075	-0.004	0.219**
	(0.139)	(0.024)	(0.091)
Expd. Inexperienced	0.074	-0.023	0.165
	(0.162)	(0.030)	(0.105)
Expd. Ancillary Teaching	-0.275	0.045	-0.039
	(0.322)	(0.039)	(0.201)
Expd. Non-teaching	-0.104	-0.008	-0.050
	(0.198)	(0.026)	(0.111)
Observations	42,784	43,556	58,327
School FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 7: **Joint Tests for 2-year Average per-pupil Expenditure Categories**

	Numeracy		**Read**		**Write**	
	F-stat	p-value	F-stat	p-value	F-stat	p-value
			All† Categories			
Grade 9	0.241	0.868	1.041	0.375	0.342	0.795
Grade 7	5.596	0.001***	2.622	0.049**	0.464	0.707
Grade 5	1.418	0.236	1.299	0.273	1.264	0.286
			Teaching Categories‡			
Grade 9	0.032	0.968	1.023	0.361	0.536	0.586
Grade 7	9.121	0.000***	2.583	0.076*	1.388	0.250
Grade 5	3.148	0.043**	7.866	0.000***	1.286	0.277
			Leadership vs. Teaching Categories◇			
Grade 9	0.232	0.630	0.049	0.826	0.740	0.391
Grade 7	2.748	0.098*	4.518	0.039**	0.185	0.667
Grade 5	0.048	0.826	1.037	0.309	0.020	0.888

† (i) Leadership; (ii) Expert Teachers; (iii) Inexperienced Teachers; (iv) Ancillary Teaching; (v) Non Teaching

‡ (i) Expert Teachers; (ii) Inexperienced Teachers; (iii) Ancillary Teaching

◇: Total (SRP) Expenditure broken into: (i) Leadership; (ii) Teaching Categories Categories and (iii) Non Teaching. Test compares coefficent of (i) with (ii).

A Appendix

Table A.1: **Student- School Summary statistics**

Variable	**Mean**	**Std. Dev.**	**Min.**	**Max.**
		Student level		
Female	0.486	0.5	0	1
Aboriginal Status (ATSI)	0.013	0.112	0	1
Eng. speaker	0.756	0.429	0	1
Mother's Occupation†				
Category I	0.096	0.294	0	1
Category II	0.143	0.35	0	1
Category III	0.194	0.395	0	1
Category IV	0.205	0.404	0	1
Category V	0.337	0.473	0	1
Category VI	0.025	0.156	0	1
Father's Occupation				
Category I	0.11	0.313	0	1
Category II	0.174	0.379	0	1
Category III	0.211	0.408	0	1
Category IV	0.203	0.402	0	1
Category V	0.103	0.304	0	1
Category VI	0.199	0.399	0	1
Mother's Education†				
Category 1	0.361	0.48	0	1
Category 2	0.16	0.367	0	1
Category 3	0.129	0.335	0	1
Category 4	0.176	0.381	0	1
Category 5	0.173	0.378	0	1
Father's Education				
Category 1	0.439	0.496	0	1
Category 2	0.205	0.404	0	1
Category 3	0.082	0.274	0	1
Category 4	0.13	0.336	0	1
Category 5	0.144	0.351	0	1
		School level		
Percent female	0.487	0.104	0	1
Percent ATSI	0.013	0.028	0	1
Percent Eng. speaker	0.756	0.23	0	1
No Principal change	0.442	0.497	0	1

†: See Table A.2 for Category description

(—Continued on next page—)

Table A.1 – continued from previous page

Variable	Mean	Std. Dev.	Min.	Max.
Primary	0.678	0.467	0	1
Secondary	0.282	0.45	0	1
Other sch. type	0.04	0.196	0	1
N		156234		

Table A.2: **Parental Occupation and Parental Education Categories**

Category	Description
	Parental Occupation Category
I	Senior management in large business organisation, government administration and defence, and qualified professionals
II	Other business managers, arts/media/sportspersons and associate professionals
III	Tradesmen/women, clerks and skilled office, sales and service staff
IV	Machine operators, hospitality staff, assistants, labourers and related workers
V	Not in paid work in last 12 months
VI	Not stated or unknown
	Parental Education Category
0	Less than Year 12 or Not stated/Unknown
1	Less than Year 12 and Certificate I to IV (including trade certificate)
2	Year 12
3	Year 12 and Certificate I to IV (including trade certificate)
4	Bachelor degree or above

Figures

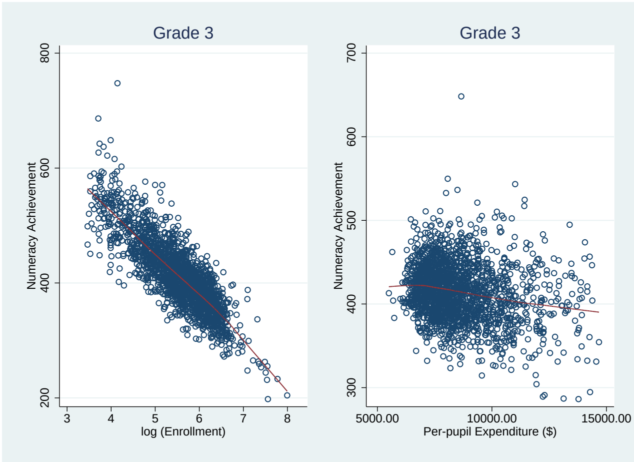

Figure 1: Non Parametric Fit (Locally Weighted Smoothing): Numeracy Achievement on log (Enrollment), square of log (Enrollment) [not shown] and Per Pupil Expenditure

Figure 2: Non Parametric Fit (Locally Weighted Smoothing): Grade 5 Numeracy Achievement on log (Enrollment), square of log (Enrollment) [not shown] and Per Pupil Expenditure

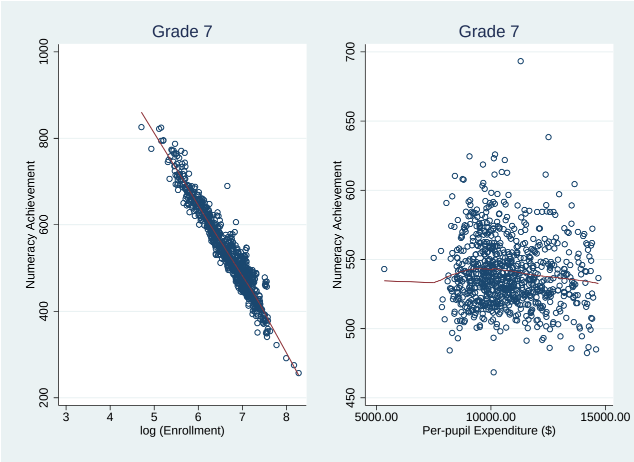

Figure 3: Non Parametric Fit (Locally Weighted Smoothing): Grade 7 Numeracy Achievement on log (Enrollment), square of log (Enrollment) [not shown] and Per Pupil Expenditure

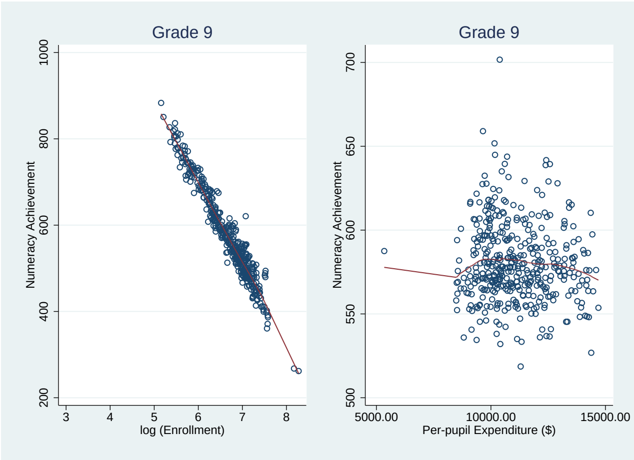

Figure 4: Non Parametric Fit (Locally Weighted Smoothing): Grade 9 Numeracy Achievement on log (Enrollment), square of log (Enrollment) [not shown] and Per Pupil Expenditure