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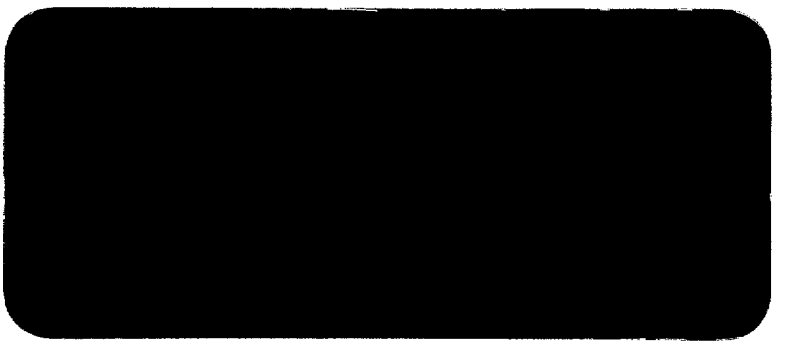

February 1997

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The papers in this series were prepared under a cooperative agreement between the Institute for Policy Reform and the Agency for International Development, Cooperative Agreement No. AEP-5463-A-00-4015-00, except for the Mason and Khandker and Deolalilar papers. Supplementary funds were provided by Save the Children Federation, the Aga Khan Foundation and the International Institute for Educational Planning. Views expressed in these papers are those of the authors, not necessarily those of these organiations.

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Determinants of Educational Achievement and Attainment In Africa

School Quality and Educational Outcomes in South Africa

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February 1997

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Abstract

We study the relationship between educational inputs-pupil-teacher ratios and school facilities - and educational outcomes - test scores, school attendance, and schooling for age. WE use data from the 1993 South African Living Standards Survey (SALLS) merged with administrative data on pupil-teacher ratios at the level of magisterial district. Even at the district level, these are large disparities in pupil-teacher ratios in South Africa, not only between Whites (19 pupils per teacher) and Blacks (41 pupils per teacher), but within the Black population, where the dispersion of pupil-teacher ratios is much larger than that for any of the other racial groups. The richness of the SALSS data, and our merging procedure, allows us to study a wide range of inputs and outputs. We find that family background variables exert a powerful effect on educational outcomes for children, but we also find a strong and statistically significant effect for pupil-teacher ratios. These effects are not detectable for Whites, and are much stronger for Blacks when pupil-teacher ratios are high than when they are low. Low pupil-teacher ratios have a positive effect on test scores, on school attendance, on years of completed schooling at any given age, and on parents' expenditures on their children's education, so that private educational expenditures complement public educational expenditures, suggesting that parents will share the costs of educational improvements with the state. These results stand in sharp contract to the often-expressed view that public expenditures have little effect on the educational attainment of children.

Acknowledgments

We are grateful to Harold Alderman, Orley Ashenfelter, David Card, Carlo del Ninno, Robert Jensen, Dulcie Krige, Alan Krueger, Francie Lund, Pieter LeRoux and Cecilia Rouse for useful discussions and comments during the preparation of this paper.

EXECUTIVE SUMMARY

One of the major challenges facing South Africa's government is the transformation of the educational system inherited from the apartheid regime. In 1993, educational expenditures per pupil were 4.6 times as much for White children as for Black children, and average years of education in the 1991 census were only 3.9 years for Blacks as compared with 9.5 years for Whites. In 1993, the pupil teacher ratio for Blacks averaged 41, compared with 19 for Whites. To improve facilities and the number of teachers for the majority Black population will be expensive, and there are many other urgent claims on government resources. There is also a literature that claims that increases in government educational expenditures in general, and teacher-pupil ratios in particular, are ineffective in improving educational outcomes, in either rich or poor countries.

We study the effects of pupil-teacher ratios—and of some other school quality measures —on a number of educational outcomes, including test scores, school attendance, and years of completed schooling at each age. Our data come in part from the South African Living Standards Survey (SALSS), collected by the South African Labor and Development Research Unit of the University of Cape Town and by the World Bank at the end of 1993. These data are supplemented by test-scores obtained from specially designed math and comprehension tests that were administered to a fraction of the respondents in conjunction with the SALSS. We have also used administrative data on pupil-teacher ratios at the level of magisterial district, and merged these into the SALSS and test-score data. Even at the district level, where data are aggregated across schools, there are wide disparities in pupil-teacher ratios, not just between racial groups, but also within the Black population. These disparities, and the very high average ratios in Black schools, provide an opportunity to examine the effects of pupil-teacher ratios in an environment where there is enough variance to identify the effects, and where possible dimishing returns are unlikely to have set in.

Test scores, the probability of being in school, and years of schooling for age are all positively influenced by family-background variables, particularly by parental education and incomes. But even allowing for these effects, pupil-teacher ratios have quantitatively important and statistically significant effects among Black children. There is some evidence that the size of the effect diminishes as the number of teachers per pupil rises, a finding that is consistent with the lack of effect of the pupil-teacher ratios on outcomes for White children. We estimate that reducing the average class size by a quarter, or about 10 pupils per teacher, would raise average educational attainment by about one-third of a year; this effect likely increases with the age of the child. The same cut would increase the probability that a Black child is in school at any given year by 0.03. The effects of pupil-teacher ratios on test-scores are less well-determined, and there is some evidence of a stronger effect on the numeracy than the literacy scores. Pupil-teacher ratios also have indirect effects on child education. Parents' expenditures on children's education are significantly higher when class-sizes are smaller, so that private expenditures are complementary with public expenditures, and parents will willingly cost-share with the state. Finally, because parents' education affects their children's education, smaller class-sizes will not only benefit the current generation, but all future generations.

1. Introduction

A major challenge for the government of South Africa is the transformation of the educational system inherited from the apartheid regime. Although educational spending in 1992 was (a relatively high) five percent of GDP, Moll (1994), the allocation of resources by race remains sharply unequal. In the 1991 census, mean years of education completed were only 3.90 for Blacks compared with 9.51 for Whites, 7.82 for Asians, and 5.46 for Coloreds, Thomas (1996), while educational expenditures per pupil relative to Blacks were 4.6 times for Whites, 3.2 times for Asians, and 2.6 times for Coloreds, Fuller, Pillay and Sirur (1995). Average pupil-teacher ratios in 1993 were 41 for Blacks, 22 for Asians, 23 for Coloreds, and 19 for Whites, Krige et al. (1994, p.66). The inequalities were even more marked in the past. Recent cohorts of Blacks have completed more years of education than their parents or grandparents; those born in 1970 had by 1991 completed more than 5 years of education compared with only 1.4 years for those born in 1920, Thomas (1996). Resources allocated to the education of Blacks were increased under the apartheid regime, especially after the Soweto riots in 1976. But while the number of enrollments expanded, Black education, particularly secondary education, was disrupted as secondary schools became a focus of political protest. As late as 1993, it was reported that schools had been closed for 6.6 million pupil-days, equivalent to the loss of a school term, Fuller, Pillay, and Sirur (1995, p.7).

The allocation or reallocation of resources during reconstruction requires knowledge of the rates of return to education, and of the costs and benefits of improving school quality. The literature on rates of return to schooling in South Africa, Moll (1994, 1995) and Mwabu and Schultz (1996) suggests that rates of return are higher for Blacks than for Whites, particularly to secondary education. But the construction of schools is not the only way of expanding educational

opportunities. The quality of schooling can be improved along various dimensions, by reducing—or by equalizing—pupil-teacher ratios, or by upgrading schools by improving buildings and other facilities such as libraries and laboratories. School quality can have both a direct effect, on the rate of return to a given quantity of education, and an indirect effect, on the amount of education, if enrollments and educational attainment respond to quality. The indirect effect will have an even more profound impact if more highly educated parents inspire their children to higher educational attainment. Little is known about the effects of educational quality in South Africa although, in a notable paper, Moll (1991) found that the earnings of Black workers were higher when they had been educated in districts with more qualified teachers, and estimated that the rate of return to improving teacher quality was higher than the rate of return to years of education at constant quality.

In the current paper, we extend what we know about the effects of school quality in South Africa by examining the effects of pupil-teacher ratios and school facilities on educational outcomes, including school attendance and educational attainment, test scores, earnings, and incomes. We use data from the South African Living Standards Survey (SALSS) that was carried out jointly by the South African Labor and Development Research Unit (SALDRU) and the World Bank in the last five months of 1993. This is an integrated household survey that was a somewhat abbreviated version of the standard World Bank Living Standards Survey, but which nevertheless collected a wide range of household and individual data for more than 44,000 individuals in slightly less than 9,000 households. This survey was supplemented by a series of community questionnaires on local facilities, and by a literacy and numeracy survey administered to a subset of individuals in the base survey. We make use of both of these supplements, as well as administrative data on pupil-teacher ratios by race and by magisterial district.

Our empirical analysis shows marked effects of school quality, particularly of pupil-teacher ratios, and particularly among Blacks. Even when we control for race, and for household background variables— which themselves have powerful effects on outcomes—we find strong and significant effects of quality on enrollment, on educational achievement, and on test scores for numeracy. Our evidence is also consistent with an effect of pupil-teacher ratios on earnings and incomes, which is perhaps the outcome that should concern us most, but we place less emphasis on this finding, because our data are far from ideal for measuring these influences.

That pupil-teacher ratios should be important determinants of educational outcomes is a proposition that appeals to common sense, but it is nevertheless controversial in the literature outside of South Africa, both for developed and less-developed countries. Surveys by Hanushek (1986), for developed countries, and (1996), for developing countries, argue that school facilities have at best a tenuous effects on outcomes, particularly on test scores. But as emphasized by Kremer (1996), a negative overall assessment of the evidence requires us to interpret statistically insignificant findings as evidence *against* an effect of school quality, and a balanced assessment leads to a more positive interpretation. But even on Kremer's reading of the literature, there is a singular absence of evidence from developing countries that the pupil-teacher ratio is an important determinant of outcomes. For the United States, recent work by Card and Krueger (1992a, 1992b, 1996) provides strong evidence for both direct and indirect effects of school quality; better schools enhance both educational attainment and earnings conditional on educational attainment. Card and Krueger pay particular attention to the experience of black Americans who were educated in the segregated South of the U.S. at a time when the differences in resources and in pupil-teacher ratios were similar to those pertaining in South Africa today. Such evidence is important, not only because of the comparison

with South Africa, but also because the effects of an additional teacher may be larger when there are 40 pupils for each teacher than when there are 20.

The paper is laid out as follows. Section 2 discusses the data that are used in our empirical work. We rely on combining a number of different sources, none of which is ideal in itself, but which together tell us much of what we want to know. Although the community questionnaire collected data on local schools and their facilities, it was one of the weakest parts of the SALSS survey, and pupil-teacher ratios are missing for a substantial fraction of the communities. We show that the administrative data on pupil-teacher ratios by race and district are good predictors of the pupil-teacher ratios that are not missing, and we take this as support for using the administrative data in the full sample. Section 3 provides an overview of educational inputs and outputs in South Africa, with particular focus on the distribution by race of pupil-teacher ratios, of educational facilities, and of test scores, incomes, and earnings. Section 4 contains our main empirical analysis. We start with an analysis of enrollment and educational attainment in relation to race, age, family background variables, and pupil-teacher ratios, an analysis that can be carried out for the complete sample in the main SALSS. We continue with a similar analysis of test scores using the smaller sample of individuals to whom the literacy survey was administered. We also look at the role of facilities other than pupil-teacher ratios, though this requires a restriction of the sample to those living in clusters covered by the community questionnaire. Finally, we give some attention to the relationship between earnings and incomes on the one hand and school facilities and test scores on the other. These results, although consistent with the rest of our evidence, are subject to multiple interpretations. There is a great deal of mobility in South Africa, and school quality has been very different at different times, so there is no reason to suppose that school quality now should have any influence

on labor market outcomes now. Indeed the reverse causality, from parental incomes to school quality, is if anything more plausible. But the data used here do not tell us where people were born, let alone where they were educated, so we cannot make the relevant match between incomes and the inputs to human capital associated with those incomes.

2. Data

There are four data sources used in this study, three associated with the SALDRU–World Bank survey. We describe each of these in turn.

2.1 The main SALSS (SALDRU1)

The main South African Living Standards Survey (SALSS) was in the field during the last five months of 1993. This is our main source of household and individual data, and we refer to it as SALDRU1. The survey collected data from 8,848 households in 360 clusters in a nationwide survey, including what were then described as "independent" homelands. The sample was stratified by province, and used a two-stage self-weighting design in which clusters were selected with probability proportional to size, and an equal number of households selected from each. The clusters are sometimes well-defined communities, particularly in rural areas, but often are not. In urban areas, the clusters may be no more than enumeration areas (census tracts), while in many rural areas in South Africa there are no well-defined villages that would make natural clusters or communities. In spite of the self-weighting design, weights had to be introduced ex-post to compensate for various practical difficulties, such as a few clusters that were too dangerous to be visited, and higher rates of refusal by Whites. However, the weights are not very variable, particularly within race and, for most calculations, it makes little difference whether or not they are incorporated.

The household roster of the survey collected data on 43,974 individuals, and each of these reported (among other things) age, relationship to the head of household, and highest educational standard achieved. For those individuals whose father or mother is in the household, we can identify the father or mother, even when he or she is not the household head. There is an education section of the questionnaire, applied to all individuals aged from 7 to 24, which asks whether the person is currently attending school and, if not, a choice of 11 reasons why not. There are also questions on time taken to get to school, and on transport modes and costs. All households are asked to record various types of educational expenditures, and whether or not household members are in receipt of scholarships, bursaries, or free school meals. More broadly, the survey collected a large amount of household information, including place of residence, magisterial district, urbanization (metropolitan, urban, and rural) and the detailed expenditure and income data that can be used to compile comprehensive (if noisy) measures of total monthly income and expenditure. These last were constructed by the survey team at SALDRU and are included in the public use versions of the data.

One problem with SALDRU1 should be noted. Interviewers were asked to weigh and measure all children aged 6 and younger. In order to shorten the interviews, some younger children were reported as being 7 years old. This misreporting is likely to cause problems with other survey responses for those reported as being 7 year olds. There are too many of them in the survey, and if there appear to be too few 7 year olds in school, it may be because some of them are actually younger. To avoid the problem, we shall often report results only for children aged 8 and above.

2.2 The SALSS community questionnaire (SALDRU2).

The main SALSS was supported by a community questionnaire which was administered to "knowledgeable" local people. The sections of the questionnaire cover the demographic composition

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of the cluster (the main population groups by race and religion), as well as economic, educational, and health infrastructure. The section dealing with education asks whether there is a primary school in the community, if so, how many and, if not, how far it is to the nearest one. For each of up to three primary schools attended by children in the cluster, information was obtained on whether it was government or private, whether a school for boys or girls or both, the number of classrooms, whether or not it had a library, a sports ground, and a swimming pool, and the number of students and teachers. The same information was collected for up to three secondary schools used by the community, with the addition of questions on whether the secondary school had a science laboratory, and whether it taught academic subjects only, technical subjects only, or a mixture of both.

In principle, the community questionnaire would allow us to match school facilities to each household in SALDRU1 but, in practice, there are serious problems. The survey organizations collecting the data did not treat the community questionnaire as seriously as they did the main survey, and the information is missing for a substantial number of clusters. For primary schools, the bulk of the questions were answered for between 271 and 281 out of 360 clusters, but two of the most important questions, on the numbers of pupils and teachers in each school, were provided for any school by only 137 and 156 clusters respectively. For secondary schools, the situation is even worse. For the questions other than those about numbers of pupils and teachers, there are answers for between 202 and 230 clusters, but we have data on pupils and teachers for even one school for only 113 and 110 clusters respectively. We have no direct information on why some clusters were covered and others not, but it is clear that there is serious risk of selection bias if we simply drop the households who live in clusters without the necessary information.

One possible procedure is to use the reported number of classrooms as a proxy for the number

of teachers, and in clusters where both are reported, there is a good correlation. However, we have no similar proxy for the number of pupils in the schools. By design, there are equal numbers of households in each sample cluster, so the survey itself is not useful for estimating cluster populations, in total or of school age. Although we have information on the population size corresponding to the sample cluster, it is clear from examination of these numbers that, in many cases, they are much too large to correspond to the community that is surveyed in the community questionnaire. Indeed, it appears to be a general problem of attaching community questionnaires to sample clusters that such clusters do not always correspond to communities in any of the usual ways that they are defined, and perhaps particularly so in Africa. As a result, we can collect data on facilities without having a well-defined population that they serve.

In the empirical analysis in Section 4, we shall report results using the facility information for the covered clusters. For the time-being, these are the only data that we have about such important facilities as laboratories and libraries, and the results seem worth reporting with the appropriate cautions. For the pupil-teacher ratios, where the data are poorest, we have an alternative source of data, the *Education Atlas*, described in Section 2.4 below. In that section, we shall compare the alternative data with that for the clusters that were covered, but we shall make no direct use of the SALDRU2 pupil and teacher data in our empirical analyses.

2.3 The literacy questionnaire (SALDRU3).

Our third data source contains test results on literacy and numeracy for a subset of the individuals in the main SALSS. The fullest description of the literacy module is given in Fuller, Pillay, and Sirur (1995, pp. 13–17). One in every six households in the SALSS was asked to participate in the literacy study, and 1,340 did so. In each selected household, the aim was to have two people take a test, one

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person to be between the ages of 13 and 18 (inclusive) and one person to be older, ideally a parent of the adolescent. We have scores from 2,381 individuals in 1,322 households. There are 1,039 individuals in the 13 to 18 group, and 1,330 who are older than 18. (A few have age missing or are younger than 13). Of these 2,369 individuals, 190 are "new" in that they do not appear in the SALSS data, something that in theory should be impossible. Of these "new" people, 63 are in the 13 to 18 age group, and once these are removed, we have 976 adolescents who took the test and whose full information is also contained in the SALSS files. It is this subsample to which we pay most attention in the analysis.

The 976 non-new adolescent test-takers are split 53:47 in favor of girls, which is not significantly different from equality. However, the test takers over the age of 18 are split 65:35 women to men. Although the descriptive material does not say so, we presume that the test was administered at times when schoolchildren were present, but when working adults were likely not to be. As a result, the older test takers are predominantly women, and less than a quarter report any wage income (either regular or casual) in the main SALSS. This selection would seem to compromise any general inferences from the adult test scores, particularly about the links between test scores and earnings.

The test itself consists of 14 questions that cover comprehension, practical mathematics, and literacy. These are designed to cover material in the school syllabus up to Standard 5, the end of primary school, normally reached by age 12. The first question is posed in English and the second in the respondent's mother tongue; both are read aloud by the interviewer. They pose simple practical problems, so that, for example, question 1 asks how long a bus trip would take to cover a given distance at a specified speed. The respondent then reads a two paragraph passage, and is asked six questions to test his or her comprehension of the written material. There are then four

computational problems (e.g. 25% of R228 = R . ?) and two practical math problems. Each question was graded correct or incorrect, and total scores computed. For the purpose of this paper, we calculated "mathematics" scores and "literacy" (or comprehension) scores. The former is the total number of correct answers on the first two questions, the four computational questions, and the two practical math questions, so that scores range from 0 to 8. The first two questions are also added into the literacy scores (they are as much about comprehension as computation) together with the six answers from the comprehension question, so that as with the math score, the literacy score ranges from 0 to 8.

2.4 The data from the *Education Atlas* (Atlas)

Our final data set comes from Krige et al. (1994), *The Education Atlas of South Africa*. The Atlas contains a large number of maps showing educationally relevant data—fractions of pupils by race, numbers of teachers, numbers of children out of school, income levels—organized by magisterial district, of which there are 363 in the country as a whole. The data that we use in this paper are the numbers of teachers and pupils of each racial group in each district, which we have matched to the magisterial district for each cluster in the SALSS survey. Of the 363 districts in the country, 188 show up in the survey. Of these, 104 contain a single cluster, 43 two clusters, 23 three clusters, up to one magisterial district (Johannesburg) that contains 13 clusters.

Because the disaggregation by district is reasonably fine, and because there is a good deal of variation across districts, it is plausible that the Atlas data will give a good indication of the pupil-teacher ratios that are relevant for the households in our survey. However, communities are often a good deal smaller than districts, and the Atlas data do not separate primary and secondary pupils and teachers, so that we have only one proxy for both. In order to assess the relevance of these data, we

examine how well the magisterial district data explain the limited number of pupil-teacher ratios available from the community questionnaire (SALDRU2). Table 2.1 shows the results of regressing the SALDRU2 pupil-teacher ratios on the corresponding Atlas pupil-teacher ratios, first for primary schools, then for secondary schools, and finally for both, with the combined SALDRU2 pupil-teacher ratio computed by summing the secondary and primary teachers in the cluster's schools and dividing by the sum of the primary and secondary pupils. Because the Atlas publishes separate pupil-teacher ratios for each race, we use the community demographic questionnaire to identify the main racial group in the community and to select the appropriate ratio from the Atlas.

Table 2.1 Relationship between pupil-teacher ratios from community survey and pupil-teacher ratios by magisterial district from Education Atlas.

	Primary Pupil-Teacher Ratio (SALDRU2)		Secondary Pupil-Teacher Ratio (SALDRU2)		Primary and Secondary Pupil-Teacher Ratio (SALDRU2)	
constant	6.26 (2.0)	3.81 (0.9)	-2.47 (0.8)	5.37 (1.1)	0.92 (0.4)	4.79 (1.1)
Atlas pupil-teacher ratio	0.87 (9.0)	1.07 (5.4)	1.01 (10.1)	0.61 (2.5)	0.95 (11.3)	0.78 (3.8)
Black	--	-6.17 (1.2)	--	8.30 (1.6)	--	3.21 (0.7)
Coloured	--	-2.30 (0.7)	--	-0.42 (0.2)	--	-.97 (0.4)
Asian	--	-3.62 (0.8)	--	0.49 (0.1)	--	-1.18 (0.4)
R^2	0.39	0.40	0.52	0.52	0.60	0.60
F and p-value for constant 0, slope 1	3.47 0.03	3.33 0.04	3.10 0.05	2.08 0.13	0.43 0.65	0.65 0.52
Number of clusters	130	130	97	97	88	88

Notes: t-statistics in parentheses.
SOURCE: authors' calculations from SALDRU2 and *Education Atlas*. The dependent variable in columns 5 and 6 is the sum of reported mean number of primary and secondary pupils divided by the sum of the reported mean number

of primary and secondary school teachers, by cluster.

For all the regressions, the Atlas pupil-teacher ratio is a strong predictor of the community level pupil-teacher ratio. For the separate primary and secondary regressions, we can only just reject the hypothesis that the slopes of the regressions are unity and their intercepts zero, so that the community level pupil-teacher ratio is equal to the magisterial district pupil-teacher ratio up to measurement error. In fact, this hypothesis cannot literally be correct, because the secondary school pupil-teacher ratios are lower than the primary school pupil-teacher ratios, but it seems that apart from this difference in levels, community pupil-teacher ratios move one for one with district pupil-teacher ratios. This interpretation is consistent with the results in the last two columns, where we use the combined pupil-teacher ratio from SALDRU2 and where we cannot reject the hypothesis that the intercept is zero and the slope is unity. Note also the relatively high R^2 statistic, albeit on sample of only 88 clusters. We also report regressions with race dummies to check that the effects of the district pupil-teacher ratios are not simply picking up differences by race. But the dummies have little effect, and the significance of the district ratios remains.

Given the problems with the SALDRU2 data for pupils and teachers, we have little choice but to use the district level data. Nevertheless, the regression results in Table 2.1 show that a substantial fraction of the intercluster variation in pupil-teacher ratios is explained by interdistrict variation. Note also that although the district ratios are noisy measures of the cluster ratios, their use as explanatory variables does not cause attenuation bias because the "measurement errors" are here the difference between the cluster measure and the district average, and these are (by definition) uncorrelated with the district means that are being used as proxies. There will of course still be a loss of efficiency in using the less precise—and less variable—district level measures.

The Atlas data are merged into the SALSS data first by matching clusters to districts and merging in the pupil-teacher ratios for each race, and then by selecting the appropriate pupil-teacher ratio on a *household* basis using the race of the household head. (The SALSS did not collect race data on all members of the household.) We are thus effectively assuming that children attend state schools according to their racial group.

3. Educational inputs and outcomes: an overview

In Section 4, we use the data to examine the effects of school quality on educational outcomes, specifically enrollment, educational attainment, and test scores. In this section, we present a descriptive overview that serves as the basis for the econometric analysis that follows. We look at years of education, enrollment, expenses for schooling, pupil-teacher ratios, other school facilities, and test scores, with a particular emphasis on the distribution by race, age, and sex.

3.1 Highest education level attained

We look first at educational attainment as measured by years of school completed. These data come from the main SALSS survey in response to a question about the highest educational level attained, which we have converted to years of education at the rate of one year per standard. While we shall often refer to this as years of education, it will be less than the number of years spent in education for students who repeat standards, or who are not in full-time education. Figure 1 shows years of education for adults by race and age, where adults are defined as those 25 and over. We adopt this high age cutoff because many young adults are still completing their education, particularly as a consequence of the disruptions to the high school system since 1976. White adults of all ages have on average eleven years of education. Except for young adult Asians, educational attainments are

less for the other groups, but have been increasing over time, so that younger cohorts have more education than older cohorts. This is particularly true for Asians, the youngest of whom have educational attainments equal to or in excess of Whites. Increasing education is also apparent for Blacks so that those born in 1968 have three years more of educational attainment than those born in 1933. The increase is slowest for Coloreds, where the average educational attainments of 60 year olds is comparable to that of Asians, while that of 25 year olds is comparable to that of Blacks.

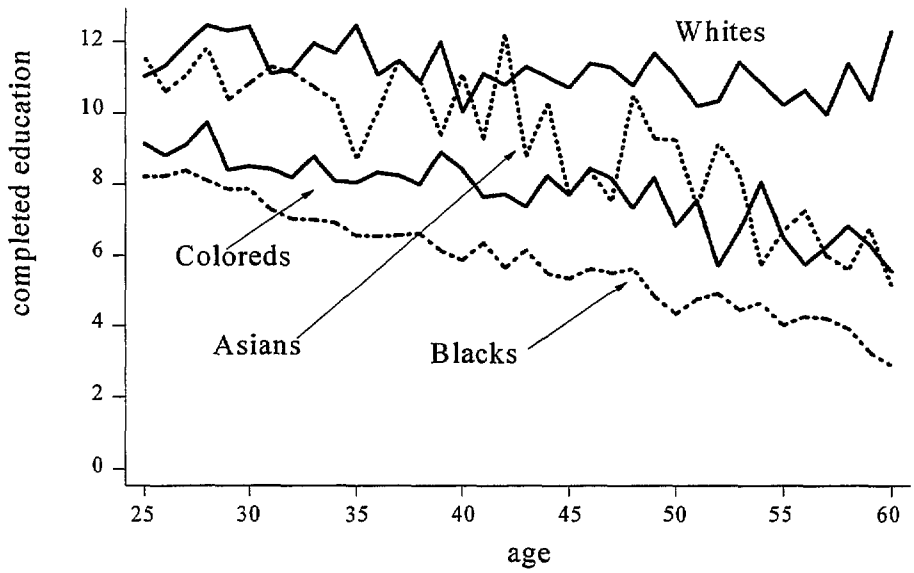

Figure 1: Number of years of education completed by age and race for adults

Figure 2 shows attainment by race and age for people aged 5 to 24. Young Asians in the SALSS have more education than other groups, though there is little difference between Asians and Whites. At age 10, educational attainment do not differ much by race, but from ages 10 to 18, there is increasing dispersion between the races. Between 10 and 18, and looking across the age cross-section,

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Blacks gain only 0.61 years of attainment for each year of age compared with 0.76 for Coloreds, 0.88 for Whites, and 0.95 for Asians. From the data to hand, we cannot tell how much of these differences can be attributed to the separate influences of dropout rates, repetition rates, and part-time versus full-time education.

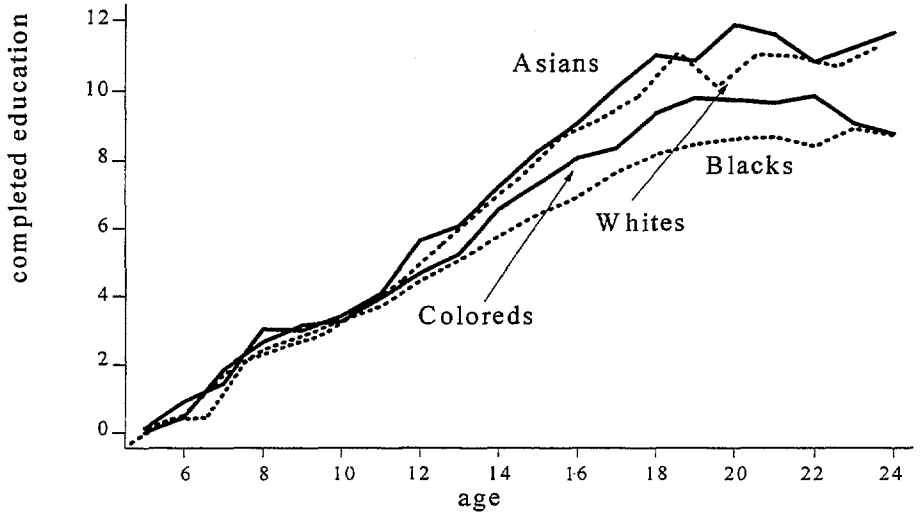

Figure 2: Educational attainment by age and race, ages 5 to 24.

3.2 Enrollment rates and reasons for non-enrollment

The SALSS questionnaire asks each person aged from 7 to 24 whether or not they are enrolled in formal education. The fractions reporting enrollment are tabulated by race and age—starting at age 8—in the top panel of Table 3.1. These data are not directly comparable to the educational attainment data in Figure 2. Attainment comes from the integral of past enrollments, not the current enrollments reported here, and a year of enrollment will not necessarily always lead to a year of completed education.

Table 3.1: School enrollment and reasons for not being enrolled

Panel A: School Enrollment by Race

Age	Black		Coloured		Asian		White	
	Percent Enrolled	Pct with Senior Cert	Percent Enrolled	Pct with Senior Cert	Percent Enrolled	Pct with Senior Cert	Percent Enrolled	Pct with Senior Cert
8	.907	.000	.918	.000	1.00	.000	1.00	.000
9	.927	.001	1.00	.000	1.00	.000	1.00	.000
10	.954	.000	.990	.000	1.00	.000	1.00	.000
11	.961	.000	1.00	.000	1.00	.000	1.00	.000
12	.966	.000	.989	.000	1.00	.000	1.00	.000
13	.963	.000	1.00	.000	1.00	.000	1.00	.000
14	.950	.000	.958	.000	1.00	.000	1.00	.000
15	.932	.001	.986	.000	1.00	.000	1.00	.000
16	.889	.002	.930	.000	.960	.000	1.00	.015
17	.855	.013	.857	.000	.912	.000	.954	.032
18	.790	.047	.795	.097	.917	.136	.970	.189
19	.677	.089	.439	.207	.455	.600	.769	.560
20	.607	.120	.288	.579	.438	.929	.500	.769
21	.477	.179	.264	.526	.105	1.00	.345	.950
22	.383	.252	.093	.600	.125	.667	.296	.809
23	.360	.220	.047	.667	.000	--	.273	.889
24	.228	.320	.020	1.00	.077	1.00	.266	.706

Note: Percent with a senior certificate is the percent of students currently enrolled who hold a senior certificate (matric/form 5/senior certificate) or have completed (form2, form3 or form 4) and received a diploma. SOURCE: SALDRU1. Files: m8_hrost.dta and m4_ed1.dta

Panel B: Reasons for Not Being Enrolled in School, Percentages by Race
For Children Ages 8 to 24

	Black	Coloured	Asian	White
Expense	21.4	4.5	0.0	0.0
Work	13.5	33.9	17.2	15.3
Illness	6.4	2.7	2.0	1.8
Pregnancy	16.5	6.3	0.0	0.4
No Local School	1.9	0.9	0.0	0.4
Could Not Cope	13.8	13.4	3.0	0.9
Boycott	0.8	4.2	0.0	0.0
Social Unrest	1.3	0.6	2.0	0.0
Completed Educ	10.7	25.9	71.7	72.9
Required at Home	3.9	3.0	1.0	1.3
Other	8.4	3.9	1.0	3.9
Missing	1.3	0.9	2.0	3.1
Number of Observations	2742	336	99	229

SOURCE: SALDRU1. Files: m8_hrost.dta and m4_ed1.dta

22

The Table shows that all Asian and White children are in school up to age 15, and that substantial numbers continue beyond age 15, particularly among Whites. Enrollment rates among Black and Colored children are lower. They start school later than Asians or Whites—which in spite of possible cohort and repetition effects appears to be inconsistent with the equality of achievement by age 10 in Figure 2—and they stop going to school earlier and in greater numbers so that, by age 18, less than 80 percent of Blacks and Coloreds are enrolled, as opposed to 92 percent of Asians and 97 percent of Whites. Beyond age 18, there are substantial fractions of Blacks in education—more than a third at age 23—as they work to complete their education. At these ages, the Black and White data look similar, but for very different reasons; the Whites are in tertiary education and the Blacks are catching up on high-school. The Table reports on the percentage of children of each age who have a senior certificate—equivalent to graduation from high school. For Blacks between 22 and 24 who are enrolled in the educational system, only between a quarter and a third have a senior certificate, as opposed to around 80 percent of enrolled Whites in the same age group.

The lower panel of Table 3.1 shows the reasons for non-enrollment by race, averaged over age from 8 to 24. Each non-enrollee is permitted to give only the most important reason, and the Table presents by race the percentages reporting each reason, which add to 100 down the columns. The most notable feature here is that 21.4 percent of Blacks report "expense" as the main reason for non-enrollment; none of the Whites or Asians give this reason. "Illness," "pregnancy," and "could not cope with school work" are also much more important for Blacks than for Asians or Whites. These figures need to be interpreted with caution, particularly in light of the very different age profiles of enrollment in the top panel of the Table. These reasons are averaged over all non-enrollees up to age

24, so that "completed education" is the main reason for not being in school for Whites and Asians, with a corresponding mechanical reduction in the other reasons. Similarly, the high numbers of people listing "pregnancy" among the Blacks needs to be seen in light of the large numbers of Blacks attempting to complete high-school in their early 20s.

3.3 Educational expenditures

Since costs of education are reported by Blacks as an important reason for not being in school, it is interesting to look at the size and structure of educational expenses as reported in Table 3.2. The average Black household with at least one member aged from 8 to 24 spends 40 rand a month (on average 2.9 percent of total expenditure) on educational expenses; on fees, uniforms, transportation, school meals, and books. For Whites, the corresponding figures are 248 rand a month or 4.6 percent of total expenditure. Black households spend R13.8 a month per child in primary school and nearly twice as much, R25, per child in secondary schools. For Whites, the figures are ten and seven times as much, R129 for a primary school child, and R165 for a secondary school child, so that even though the average White household spends five times as much in total household expenditure as the average Black household, the share of educational expenses in the budget is larger for Whites. About a quarter of educational expenditures by Black households goes to school uniforms, and rather more than another quarter on transportation and school meals. These three items account for less than a quarter of the educational budget of White households.

Table 3.2: Household educational expenses
Monthly Averages

	Households with at least one member aged 8 to 24			
	Blacks	Coloureds	Asians	Whites
Primary School Fees	2.85	3.10	2.59	43.25
Secondary School Fees	3.40	1.84	1.48	36.78
Tertiary Tuition	5.88	7.55	32.72	60.56
Uniforms	9.89	13.11	16.15	19.42
Transportation	5.37	5.28	10.09	27.88
School Meals	6.14	0.50	1.05	1.64
Books	2.06	1.23	2.97	7.34
Total Expenditure on Education	39.80	37.35	84.44	247.70
Total Monthly Household Expenditures	1105.07	1814.32	3274.54	5027.37
Share of Education in Total Monthly Expenditures	2.87	1.70	2.16	4.60

Note: Educational expenditures are reported in the SALSS survey on an annual basis. They are divided by 12 here to put them on a basis that can be compared with other reported expenditures. Mean monthly household school expenditures on one primary school child sum to: R13.75 for Blacks; R16.93 for Coloureds; R26.27 for Asians; and R129.06 for Whites. Mean monthly household school expenditures on one secondary school child sum to: R25.22 for Blacks; R19.42 for Coloureds; R22.28 for Asians; and R164.79 for Whites. (Tertiary tuition and pre-primary school fees were omitted from these calculations.) SOURCE: SALDRU1. Files: m1_ed2.dta and hhexptl.dta.

3.4 Pupil-teacher ratios

Table 3.3 and Figures 3 and 4 show summary statistics for the pupil-teacher ratios from the Atlas data as merged into the SALSS sample. Each *individual* in the survey—whether of school age or not—is assigned the pupil-teacher ratio for the appropriate racial group in the district in which he

or she lives. These are then averaged over individuals (using inflation factors from the sample design) to give the data shown in Table 3.3. While these are filtered through the SALSS, and are therefore not the same as the national figures given in the *Educational Atlas*, they are almost identical, as should be the case for a large national sample. Note that these procedures understate the true variance of pupil-teacher ratios across individuals, because we are ignoring the dispersion across individuals in the same magisterial district.

Table 3.3: Pupil-teacher ratios

	Mean	Standard Deviation	Number of Observations
Black	41.67	7.36	31428
Coloured	23.52	2.09	3180
Asian	22.06	1.61	1120
White	18.91	1.81	4038

Source: Numbers of pupils and teachers are reported for each racial group, by magisterial district, in the Educational Atlas. These were used to create a pupil teacher ratio by racial group for each district. Each individual in the SALSS survey was then assigned the pupil teacher ratio corresponding to his or her racial group and magisterial district. The means reported here are weighted using SALSS sampling weights (variable=rsweight). (The unweighted means differ only in the first decimal place.)

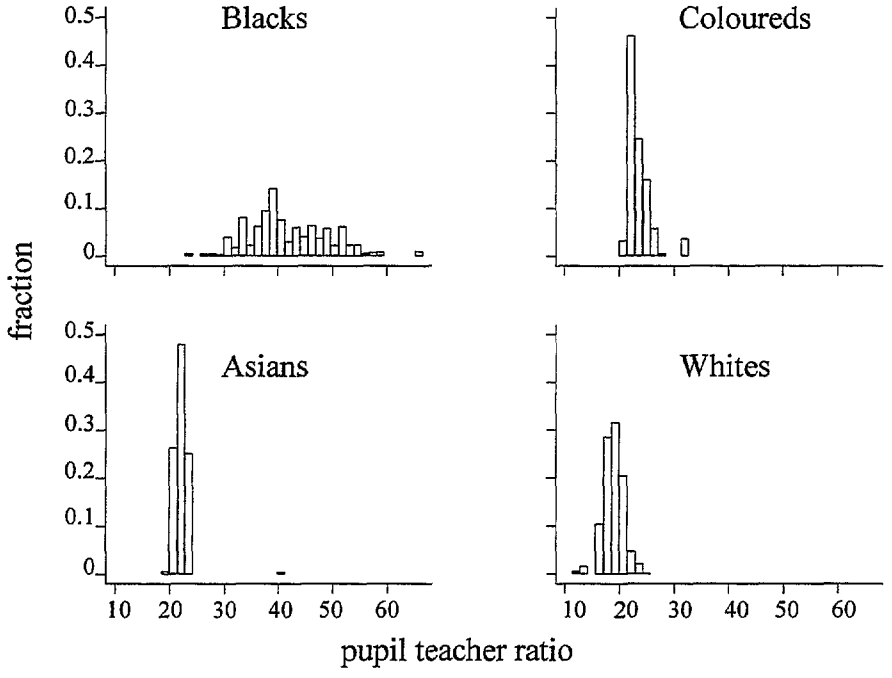

Figure 3: Distributions of pupil teacher ratios for persons in SALSS, by race, from district data.

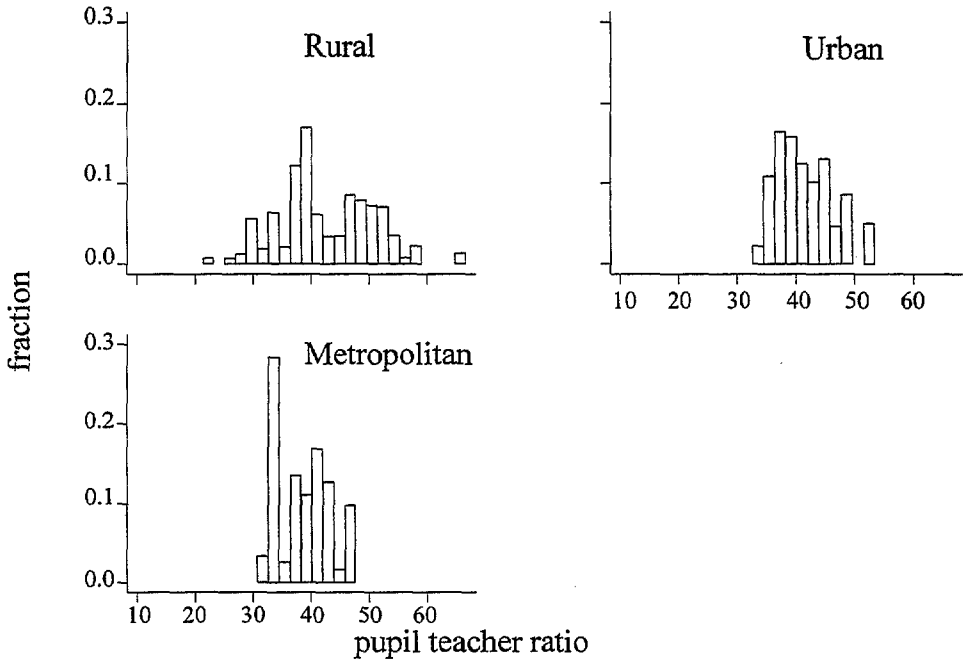

Figure 4: Distributions of pupil teacher ratios for Blacks in SALLS, by level of urbanizations, from district data

Apart from the obvious and very large difference in pupil-teacher ratios between Blacks and the other groups, the most notable features of the Table and of Figure 3 is that pupil-teacher ratios are much more dispersed within the Black population than is the case for the other groups. To some extent, this is a consequence of the fact that some groups—particularly coloreds and Asians—are concentrated in a relatively small number of districts—but the differences are striking. Figure 4, which is for Blacks only, shows that the dispersion is greatest in rural areas, again in part coming from the larger number of rural districts.

In the econometric analysis in Section 4, we shall treat the district level pupil-teacher ratios as exogenous variables, using their variation to explain educational outcomes such as test scores and

years of completed education. In this we follow most of the literature on school quality, but we should be much more comfortable doing so if we had a better idea of what determines the differences across districts. Under the apartheid regime, the education of Blacks (outside of the "independent" homelands) was controlled by a Department of Education and Training which was set apart from the central and provincial bodies responsible for the education of the White population. Given the very limited control that the Black population had over its own education, it is perhaps plausible to maintain that .the variation in resources across districts was independent of the educational choices of Black households and children. Nevertheless, the proposition requires more documentation than we have been able to muster to date, though it is a topic on which we plan further work. In particular, the data from the 1991 census can be used to construct district counts of population by age and race, as well as counts of school teachers and their incomes. Such measures could be used to test models of how resources are allocated across district. For example, Boozer, Krueger and Wolkon (1992) confirm earlier observations that, in the segregated south of the United States, interstate differences in the resources made available for black education depended inversely on the proportion black in the state. Given that the apartheid regime allocated funds by race at the center, such a relationship seems less likely in South Africa, and we find no trace of it in the SALSS and Atlas data. Nevertheless, the study of this and similar phenomena in the South African context is an important next step in the analysis.

3.5 Other school facilities

Although the data on school facilities are to some extent compromised by the lack of completeness in SALDRU2, we report the information that we have in Table 3.4. The Table reports the fraction of schoolchildren (from age 5 to 18) who have access to each of the facilities shown in the rows of

the Table. These are computed by assigning to each school-age child a one or zero depending on whether or not the facility is reported as present in the cluster, and then averaging over all non-missing observations.

Table 3.4: School Facilities: Fraction of school aged children (5 to 18) with each facility available in their cluster

	Black	Coloureds	Asian	Whites	Number of Clusters Reporting
Primary School Library	.110	.854	1.00	.943	279
Secondary School Library	.380	1.00	1.00	1.00	227
Secondary School Laboratory	.390	1.00	1.00	.958	227
Primary School Sports Facility	.602	.612	1.00	.971	281
Secondary School Sports Facility	.635	.779	.824	.999	228
Primary School Swimming Pool	.012	.059	.005	.397	273
Secondary School Swimming Pool	.034	.014	.174	.446	222

SOURCE: SALDRU2 (Community Questionnaire).

The results confirm that it is not only pupil-teacher ratios that are unequally allocated. Only 11 percent of Black children live in communities where the primary school has a library, compared with almost all of Asian and White children. Only 39 percent of Black children live in communities where there is a secondary school with a science laboratory, again compared with nearly all Asian and White children. Sports facilities are also unequally distributed, and even if we believe that sports facilities are less important to educational achievement than are libraries or laboratories, their

distribution is likely to mirror school facilities in general.

3.6 Test scores

Table 3.5 reports on the test scores. These results are restricted to the test-takers who are also present in the full SALSS survey, and we show them separately for the group aged 13 to 18, and for those older than 18; the former are less contaminated by the selection than are the latter and we focus on them in the econometric results below.

Table 3.5: Literacy and numeracy test scores

Panel A
Test Scores, Children

	Literacy Scores		Numeracy Scores	
Means for Age:	Blacks	Whites	Blacks	Whites
13	2.64	5.32	1.77	4.89
14	2.87	4.57	2.02	3.86
15	2.92	5.76	2.25	4.15
16	3.35	6.00	2.44	5.21
17	3.14	5.81	2.22	5.38
18	3.46	5.88	2.59	5.65
Number of Observations, Ages 13-18	756	108	756	108

Panel B
Test Scores, Adults (19 and older)

	Blacks	Coloureds	Asians	Whites
Literacy Scores:	3.06	4.63	5.98	5.90
Numeracy Scores:	2.32	3.37	5.71	5.58
Number of Observations	840	105	52	206

SOURCE: SALDRU3.

In Panel A, we report only on Blacks and on Whites, since the disaggregation by age leaves too few Coloreds and Asians to give useful averages. Both groups did better on the comprehension tests than on the math tests and, for Blacks, test scores improve with age; we shall see in Section 4 that this improvement is in fact a function of years of education, and not of age. For Whites, the evidence of improvement with age is more limited or absent. Since the test is set at around the Standard 5 level, which most Whites (and Asians) have completed by age 12, it is plausible that they do as well as they are ever going to do by age 13. Among the adults, test scores are highest among the Asians—which is also true among the much smaller Asian sample aged 13 to 18—but once again, the scores for Blacks are around half of those for Whites.

3.7 Educational attainment, earnings, and expenditures

We conclude with a first look at the relationship between educational attainment and various measures of economic success at both the household and individual level. Figures 5 and 6 show plots of the logarithm of wage (the return to human capital) on educational attainment (the amount of human capital). These graphs present information for only those individuals who report formal sector earnings, which in South Africa is only about a quarter of the potential labor force. The graphs do not cover all groups for all education levels because we do not show the plot when there are insufficient observations, usually ten or fewer at a given level. Except at the lowest levels, higher education is associated with higher formal-sector wage rates for both men and women. The graphs suggest that, at higher levels of education, the *slopes* of the education-wage profiles are steeper for Blacks than for Whites. However, most Whites have more than ten years of education, and most Blacks less than ten years, and an additional year of education is associated with about the same rate of increase of wages for both groups.

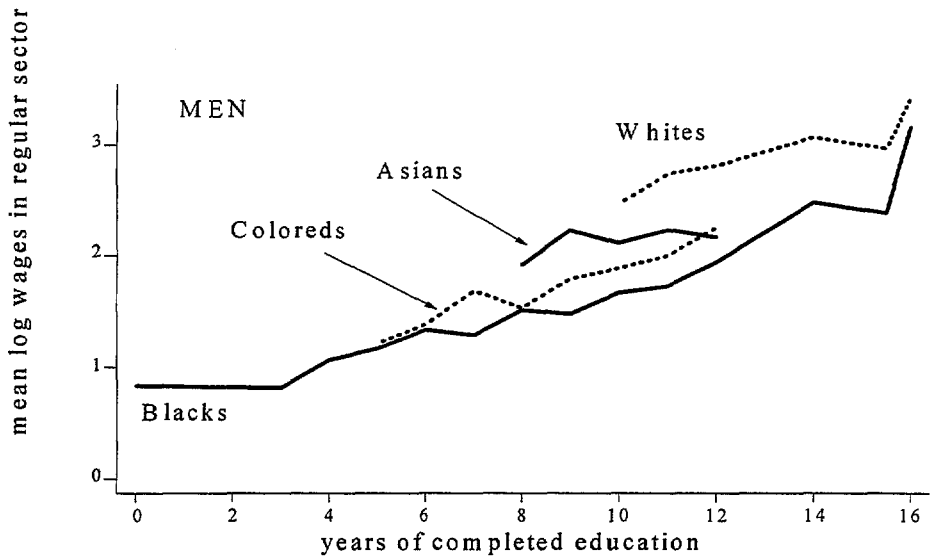

Figure 5: Mean log formal sector wage rates for men by race and years of completed education.

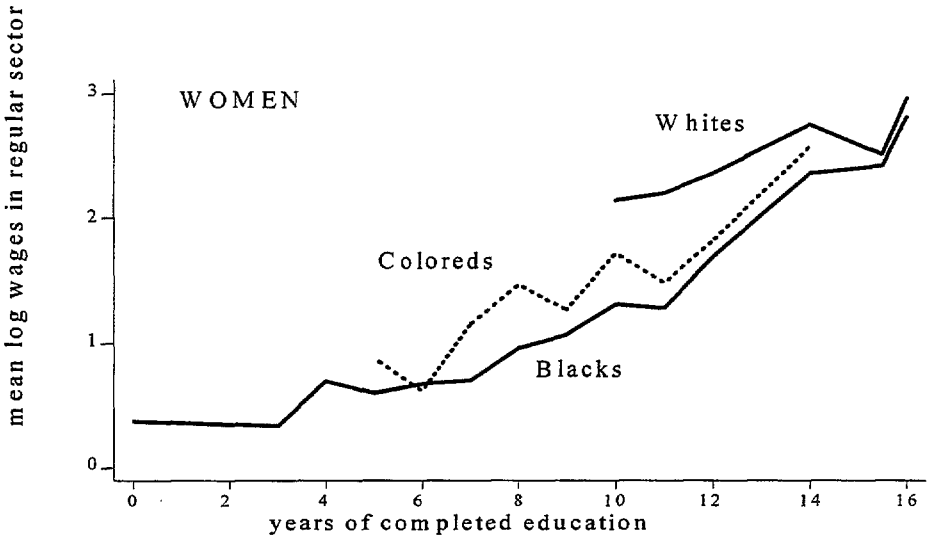

Figure 6: Mean log formal sector wage rates for women by race and years of completed education.

Figures 7 and 8 show that two other economic measures, total household income and total household expenditure, are related to the educational attainment of the household head. Again we present estimates only when there are sufficient data. As with earnings, these measures of household economic status are strongly linked to educational attainment, with the slope for better educated Blacks steeper than that for Whites. The use of income and expenditure measures makes the interpretation of these figures less clear than is the case for earnings, but they have the advantage of covering all households in the sample, not just the minority that participate in the formal labor market.

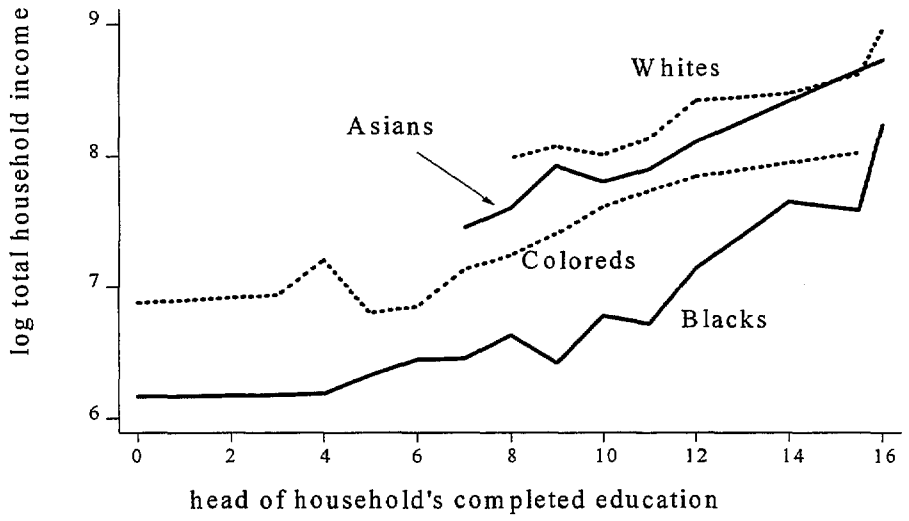

Figure 7: Mean log total monthly household income by race and education of the head.

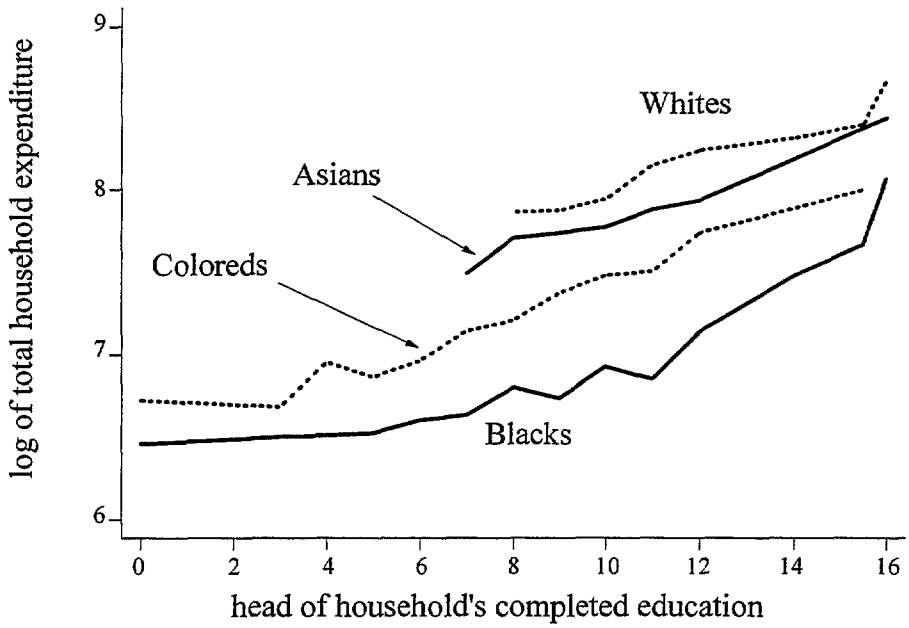

Figure 8: Mean log total household expenditure by race and education of household head.

Figure 9 shows the distribution of head's education. The majority of Black heads have no more than a primary education, while at the other end of the distribution, a large fraction of White heads have education beyond high-school.

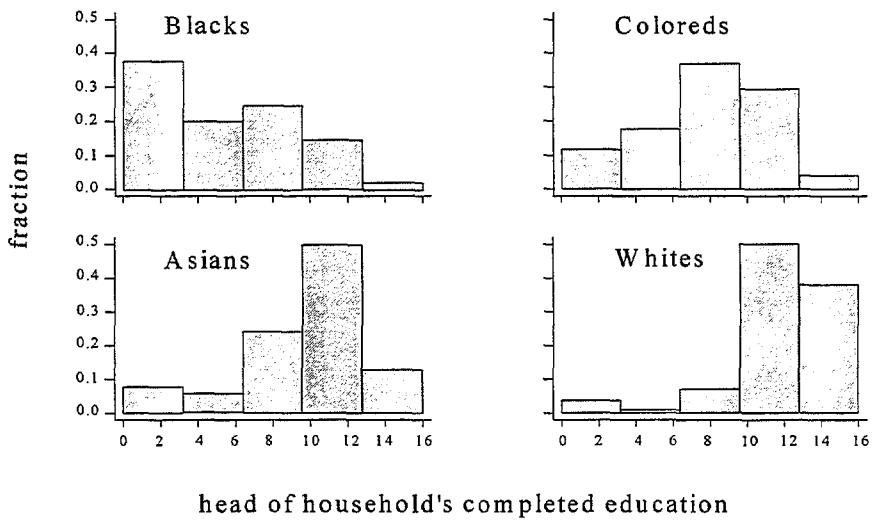

Figure 9: Educational attainment of heads of household, by race.

4. Educational inputs and educational outcomes: econometric analysis

In this section, we examine the relationship between school inputs, particularly the pupil-teacher ratio, and various measures of educational outcomes, including educational attainment, enrollment rates, the reasons for not being in school, educational expenditures, test scores, and measures of economic success, such as earnings, income, and expenditures. We present the results of a series of regressions in which the pupil-teacher ratio (or the presence of other facilities) is an explanatory variable. Among the other controls are age, race, urbanization, sex, and various measures of family background, such as whether the household is headed by a woman, household size, the educational attainment of the head, and the logarithm of total household expenditure per capita. We shall

typically run regressions with and without the family background variables. We are concerned with the possibility that a relationship between (say) pupil-teacher ratios and educational outcomes might result from the effects of omitted family background variables on both, and we can learn about this from the sensitivity of the estimated effects of the pupil-teacher ratio to their inclusion. If a low pupil-teacher ratio is driven by the fact that better-off households have a higher demand for education and also ensure that their children are better educated, the effects of the pupil-teacher ratio will be attenuated or eliminated by including family resources directly. We also think it likely that head's education is a direct input into the educational process, as are household resources, here proxied by total household expenditure per household member, a quantity that is both better measured than income and a better indicator of longer-term living standards.

In the regressions presented below, we have chosen to use the log of the pupil-teacher ratio, instead of the ratio itself. There is no obvious theoretical reason to prefer the ratio over its logarithm, and the latter has the advantage of making the regressions invariant to whether we work with the pupil-teacher ratio or the teacher-pupil ratio. The results are robust to replacing the logarithm with the pupil-teacher ratio.

4.1 Pupil-teacher ratios and educational attainment of adolescents

Table 4.1 presents the results of an analysis of years of completed education for children aged 10 to 18. The dependent variable in our baseline regression in column (1) is educational attainment measured as years completed; among the explanatory variables, age is entered as a series of dummies, one for each year, with age 10 omitted. Age is the obvious and immediate correlate of educational attainment for young people who are still in the educational system and it would makes no sense to model educational attainment except in relation to age. The regression shows educational

attainment rising with age, with between 0.6 and 0.7 of a year of attainment associated with each additional year of age.

Table 4.1: Determinants of Years of Completed Education for Children Aged 10 to 18

	ALL	WHITES	BLACKS				
	(1)	(2)	(3)	(4)	(5)	(6)	TSLS
Indicator: Age = 11	.438	.851	.392	.366	--	--	.380
	(5.9)	(4.2)	(4.6)	(4.2)			(3.7)
12	1.18	1.66	1.08	1.08	--	--	1.09
	(16.1)	(7.8)	(13.0)	(12.6)			(10.8)
13	1.82	2.65	1.70	1.69	--	--	1.80
	(24.6)	(12.7)	(20.2)	(19.3)			(17.7)
14	2.59	3.71	2.40	2.42	--	--	2.49
	(35.3)	(18.1)	(28.7)	(27.9)			(24.5)
15	3.30	4.70	3.08	3.10	--	--	3.16
	(43.8)	(21.8)	(36.0)	(34.8)			(30.6)
16	3.88	5.74	3.56	3.55	--	--	3.65
	(50.8)	(27.0)	(40.9)	(39.2)			(34.7)
17	4.56	6.40	4.26	4.26	--	--	4.28
	(59.5)	(29.7)	(49.0)	(47.1)			(40.8)
18	5.09	7.06	4.77	4.79	--	--	4.78
	(68.6)	(32.9)	(56.5)	(54.7)			(46.4)
Age in years	--	--	--	--	.616	1.04	--
					(78.5)	(6.1)	
Log (Pupil-Teacher Ratio)	-1.64	-.265	-1.80	-2.00	-1.80	1.03	-3.27
	(8.3)	(0.5)	(7.8)	(8.4)	(7.8)	(1.7)	(2.4)
Female	.419	-.007	.499	.492	.498	.499	.465
	(11.7)	(0.1)	(12.3)	(11.7)	(12.3)	(12.4)	(9.4)
Head of Household's Completed Educ	.075	.061	.076	--	.076	-.053	.079
	(14.8)	(4.2)	(13.5)		(13.5)	(1.8)	(11.3)
Log (Household Size)	.173	-.669	.203	--	.199	.196	.198
	(3.6)	(3.0)	(3.9)		(3.8)	(3.8)	(3.1)
Indicator: Female Head	.131	.136	.122	--	.123	.118	.155
	(3.2)	(0.7)	(2.8)		(2.8)	(2.7)	(2.7)
Log (Expenditure per Household Member)	.477	-.086	.509	--	.512	-.383	.430
	(14.3)	(0.8)	(13.5)		(13.5)	(2.3)	(9.3)
Age*Head's Completed Education	--	--	--	--	--	.009	--
						(4.4)	

Age*Pupil Teacher Ratio	--	--	--	--	--	-.208 (4.9)	--
Age*Log(Expenditure per Household Member)	--	--	--	--	--	.064 (5.5)	--
F (Head Ed,Age*HeadEd)						102.2	
F (P-T,Age*Pup-Teacher)						43.53	
F (Log Exp, Age*LogExp)						105.8	
Number of Obs	8650	629	7110	7110	7110	7110	4970

Notes on Table 4.1

Metro and province indicators included in all regressions.
Race indicators included in column 1. SOURCE: SALDRU1 and Education Atlas.
One magisterial district is dropped because of an outlier in white population (47 observations in Umlazi, KwaZulu removed).

In column (7), log (pupil-teacher ratio) is instrumented on the fractions of the population in the magisterial district that are black, asian, and white. (Source: 1991 South African Census.) Transkei, Ciskei, Bophuthatswana and Venda (TBVC) were not enumerated in the census and are missing from the TSLS estimation. If we attribute a 100% black population to the magisterial districts in TBVC, the TSLS estimate of the log (pupil-teacher ratio) coefficient is -3.04 (t-statistic = 2.2).

The f-test of the joint significance of population fractions black, asian and white in the first stage regression for column (7) is 97.34.

An over-identification test of orthogonality between the residuals of the main regression and the instruments yields a chi-square value of 3.35 (p-value =.1879).

The pupil-teacher ratio has a negative impact on attainment, with a *t*-value of 10. According to the estimate, reducing the average class size by a quarter or roughly 10 pupils per teacher, for example, would raise average educational attainment by 0.31 years, equivalent to adding about six months to age. Female students have 0.4 of a year of educational attainment more than male students, and there are the expected positive effects of household resources and of the education of the head. Head's education is a strong predictor of educational attainment; a head completing 12 years of education as opposed to 8 years, the difference between completing primary school and

completing secondary school, is predicted to raise the educational attainment of members of the household by a quarter of a standard, about the same as the effect of reducing the pupil-teacher ratio by 10. This effect will enhance the long-run benefits of lowering pupil-teacher ratios, since a better-educated current generation will have better-educated children.

Results are similar if the log pupil-teacher ratio is replaced by the pupil-teacher ratio and its square. In these regressions (not presented), the pupil-teacher ratio has a positive and insignificant effect on educational attainment, but its square has a negative and significant effect on years of completed education. This suggests that the marginal impact of adding additional students is greater at larger class sizes.

The second and third columns show the same regression for Whites and for Blacks; there are 7,157 Black children aged 10 to 18 in the SALSS with complete information, but only 629 Whites, and correspondingly fewer Coloreds and Asians, the results for whom we do not present. The results for Blacks and for Whites are quite different. The coefficients on the age-dummies rise more rapidly with age for Whites than for Blacks; as we have seen, Whites make more rapid progress through the school system than do Blacks. Female students do better than male students if they are Black; there is no similar effect for Whites. The education of the household head is the one family background variable that operates similarly for Whites and Blacks; in both cases there is a large positive and significant effect.

For the purposes of this paper, the two most interesting contrasts are in the effects of resources, private resources through expenditure per head, and public resources through the pupil-teacher ratio. Household resources have no effect on the educational attainment of White adolescents, but a marked positive effect on the education of Blacks. This suggests that the expenditure term should

be interpreted as a resource effect; education is cheap enough so that funding is not a constraint for Whites but can be a serious constraint for the much poorer Blacks. The same appears to be true for the pupil-teacher ratio, whose strong negative effects in the first regression are entirely due to Blacks. Consistent with much of the literature for the United States, the pupil-teacher ratio has no obvious effect on educational attainments of White adolescents, among whom the pupil-teacher ratios are around 19. For the Black students, where the pupil-teacher ratios in primary and secondary schools are more than twice as big, higher pupil-teacher ratios have a strong and significant negative effect on attainment.

Column (4) explores the consequences of excluding the family background variables for Black students. Although these are significant in the regression in Column (3), their removal does not affect the other coefficients, and in particular does not alter either the size or significance of the pupil-teacher ratio. These results are consistent with the family variables being important in their own right, and provide no support for the proposition that pupil-teacher ratios are simply picking up the effect of excluded background variables.

The final three columns in the Table explore the possibility that the effects of pupil-teacher ratios should interact with age. The basic idea is that low pupil-teacher ratios act not on educational attainment itself, but on the process of acquiring education, so that students make more rapid progress through the educational system when there are more teachers for each student. Low pupil-teacher ratios may also cause pupils to start education earlier. The pupil-teacher ratio should then affect the intercept of the relationship between attainment and age, as well as the slope, which is the rate at which age turns into educational attainment. It is clumsy to allow these interactions with a list of dummies for age, so we start in column (5) with a regression in which age is restricted to

appear linearly. The coefficient is 0.618, and the other coefficients are unaltered. In column (6), we build on this specification by adding an interaction term between age and the pupil-teacher ratio, whose coefficient attracts a t-value of -5.4. The original intercept term remains significant, so that both terms belong in the regression and the F-test for their joint inclusion is 64.8. Column (6) extends this interactive specification to the effects of head's education and the logarithm of per capita household expenditure. All three of the interaction terms are significant in this regression, so that the evidence is consistent with the idea that money, family education, and pupil-teacher ratios all work by helping people progress more rapidly through the educational system, presumably through some combination of increasing the probability of enrollment and of completing each standard more rapidly conditional on enrollment.

4.2 Enrollment rates and reasons for non-enrollment

Table 4.2 shows estimates of linear probability models for enrollment status and reasons reported for being out of school among those not enrolled. These are run for Blacks aged from 8 through 24 inclusive. In the first column, a dummy variable that is one for enrollment and zero otherwise is regressed on the pupil-teacher ratio and the family background variables, together with (not shown) the age dummies, household size, and urbanization dummies. In columns (2) through (7), the right hand side variables are the same, but the sample is restricted to those who are not enrolled, and the dependent variable is one if the reason indicated is the given reason, and is zero otherwise. Since each unenrolled person gives one and only one reason, the coefficients in these columns would add to zero—except for the intercepts which would add to unity—if all the reasons were reported here. Note finally that in column (5), which refers to pregnancy as a reason for non-enrollment, the sample

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is restricted to females.

Table 4.2: School Enrollment: Blacks Aged 8 to 24

Linear Probability Models

	Dep Var:	Dep Var: Reason Stated for No Longer Attending School				
Explanatory Variables:	Currently Enrolled	Expense	Work	Illness	Pregnancy (females only)	Can't Cope
Log(Pupil-Teacher Ratio)	-.110 (6.4)	-.030 (0.7)	-.027 (0.8)	.088 (3.3)	-.246 (3.7)	.071 (1.9)
Indicator: Female	-.013 (2.1)	-.013 (0.8)	-.134 (10.5)	-.008 (0.9)	--	-.121 (9.1)
Household Head's Educ	.006 (7.4)	-.003 (1.4)	-.000 (0.2)	-.003 (2.5)	.010 (3.1)	-.003 (1.5)
Indicator: Female Head	.023 (3.6)	.003 (0.2)	-.011 (0.8)	-.001 (0.1)	.046 (1.8)	-.004 (0.3)
Log (Expend per hh mem)	.050 (10.1)	-.085 (6.7)	-.028 (2.7)	.022 (2.8)	-.015 (0.8)	.011 (1.0)
Log(household size)	.061 (9.1)	-.025 (1.7)	-.084 (7.0)	.006 (0.6)	.081 (3.4)	.036 (2.9)
Number of Obs	12683	2696	2696	2696	1465	2696
R^2	.317	.056	.049	.028	.082	.049

Notes
t-statistics in parentheses.
Also included in the regressions are age indicators, urban and rural indicators. "Can't cope" refers to the respondent stating that he or she could not cope with the school work.
SOURCE: SALDRU1. Files: m4_ed1.dta, m8_hrost.dta, hhexptl.dta and the Education Atlas.

The results for enrollment in column (1) are qualitatively consistent with our findings on educational attainment in Table 4.1, particularly as concerns the effects of public and private resources on education. The log of the pupil-teacher ratios has a significant negative effect on the probability of being in school. Using the same example as before, a cut in the pupil-teacher of a quarter would increase the probability of enrollment for Black students by 0.03 in a single year. The same cut is estimated in Table 4.1 to increase average educational attainment for 10 to 18 year olds

by –0.31, which is somewhat larger than the prediction from the enrollment effects. As we have already noted, enrollment and attainment are not mechanically linked, so that it is hard to use the comparison as a cross-check. As with attainment, the effect of a four year increase in head's education is about the same as a 10 pupil drop in the pupil-teacher ratio and, in both cases, household resources enhance education. Household resources also have an effect on *why* people are out of school. Adolescents in better-off households are less likely to cite expense or work as the reason for not being enrolled, but are more likely to have completed their education or to cite ill-health, perhaps an example of the general phenomenon that self-reported ill-health is higher among higher income people. The pupil-teacher ratio also has marked effects on the reasons for being out of school. When there are more teachers for each pupil, people are less likely to be absent because they can't cope with the schoolwork or because they are ill, but are more likely to be absent because they have completed their schooling or because they are pregnant, the last a somewhat puzzling result, but note the similar effect of head's education.

4.3 Determinants of household spending on education

Table 4.3 reports the results of a simple demand analysis for household expenditures on educational expenses, with separate reporting of its components that are attributable to primary, secondary and tertiary school fees. We show results for Black households on the left and for White households on the right. The dependent variables are the various educational expenditures—total expenditure, primary school fees, secondary school fees, and fees for tertiary education—expressed as a percentage of total household expenditures on all goods and services. These are related to the pupil-teacher ratio as well as to the logarithm of total expenditure per head, the logarithm of household size, race and location dummies, a dummy for female headed households, and a series of variables

that measure household structure as represented by the ratios to household size of the number of people in various age groups.

Table 4.3: Determinants of Schooling Expenditures

Regression estimates: Dependent variable is the percentage share of the expenditure listed at column head in total household expenditure

	BLACK HOUSEHOLDS				WHITE HOUSEHOLDS			
	Total School Exp	Primary School Fees	Secondary School Fees	Tertiary Tuition Fees	Total School Exp	Primary School Fees	Secondary School Fees	Tertiary Tuition Fees
Log Expenditure Per Household Member	.681	-.079	-.012	.321	.673	-.078	-.089	.633
	(8.5)	(7.8)	(0.7)	(7.6)	(3.1)	(1.2)	(1.5)	(4.1)
Log (Pupil Teacher Ratio)	-2.27	-.221	-.234	-.756	-2.50	-.874	.065	-.769
	(7.6)	(6.0)	(3.8)	(4.9)	(2.3)	(2.7)	(0.2)	(1.0)
Household Head's Education	.053	.005	.009	.016	.022	.007	.003	.007
	(4.0)	(3.1)	(3.1)	(2.3)	(0.7)	(0.7)	(0.3)	(0.3)
Indicator: Female Head	.318	.012	.048	.027	.940	-.042	.140	.407
	(2.9)	(0.9)	(2.1)	(0.5)	(2.8)	(0.4)	(1.5)	(1.7)
Log (household size)	1.67	.023	.118	.420	2.24	-.024	.309	1.35
	(16.5)	(1.8)	(5.5)	(7.9)	(6.6)	(0.2)	(3.3)	(5.6)
Number prime age/household size	.021	.070	.033	-.058	.249	-.028	.081	.292
	(0.1)	(1.9)	(0.5)	(0.4)	(0.7)	(0.2)	(0.8)	(1.1)
Number 0-5/Household size	-1.95	-.059	-.296	-.508	-1.15	.300	-.889	-2.02
	(4.2)	(1.0)	(3.0)	(2.1)	(1.2)	(1.0)	(3.4)	(2.9)
Number members 6-15/Household size	1.93	.644	-.032	-.439	7.44	3.71	.556	-1.75
	(4.9)	(12.8)	(0.4)	(2.1)	(9.5)	(15.9)	(2.6)	(3.1)
Number members 16-18/Household size	4.99	.234	1.17	.036	9.62	-.295	5.02	.351
	(9.3)	(3.5)	(10.3)	(0.1)	(8.1)	(0.8)	(15.6)	(0.4)
Number members 19-21/Household size	2.42	.021	.361	.245	9.17	.034	1.03	5.59
	(5.2)	(0.4)	(3.7)	(1.0)	(10.9)	(0.1)	(4.7)	(9.3)
Number members 22-24/Household size	1.95	.007	.147	1.13	2.25	-.029	-.012	1.94
	(4.6)	(0.1)	(1.6)	(5.1)	(3.7)	(0.2)	(0.1)	(4.5)
R^2	.139	.113	.051	.032	.323	.293	.278	.123
Number of Obs	6246	6380	6382	6400	1305	1340	1340	1337

Notes:
t-statistics are reported in parentheses.
Data are from the SALSS 1993 survey. Total school expenditure is the sum of pre-primary, primary, secondary and tertiary school fees, books, stationery, meals, transportation, uniforms, boarding fees, contributions to school buildings, extra costs for teachers, extramural activities, and other expenditures.
Also included in the regressions are rural and urban indicators and a constant.

The household structure variables are included to allow the three types of educational expenditures to respond to the size and age-structure of the household, and the Table shows clearly the association between primary school expenses and primary school children, secondary school expenditures and adolescents— and young adults for Blacks—and tertiary school expenses and the 19 to 24 age group. Although the age-patterns are qualitatively the same for Blacks and Whites, the coefficients are much larger for the latter. School expenditures as a whole are a luxury good—the share of the budget rises with total outlay with almost identical coefficients for Whites and Blacks—but primary and secondary school fees are necessities. Black households with more highly educated heads spend more on education, even controlling for total expenditure.

For Black households, the logarithm of the pupil-teacher ratio attracts negative and significant coefficients for total educational expenditures and for each type of fees. For White households, the sample is smaller and standard errors are larger, but the negative effect on total expenditures is around three times as large as for Black households. There are also negative coefficients for the effects of the pupil-teacher ratio on primary and tertiary fees, but not for secondary fees. This is the opposite of what would happen if high pupil-teacher ratios drove White pupils out of public schools in which case there would be a *positive* association between pupil-teacher ratios and school expenses. One interpretation of the results in the Table is that public and private expenditures on education are *complements*, so that parents spend more on education expenses for their children when the base quality is higher. This would then be one of the mechanisms by which pupil-teacher ratios affect educational attainments in the regressions in Table 4.1, which do not condition on educational expenditures. As with head's education, the general point is that lowering pupil-teacher ratios is likely to have benefits beyond the direct effect of better tuition on pupils currently in school.

Of course, such results should be treated with caution. It is less than clear why lower pupil-teacher ratios should increase household expenditures on *tertiary* education, although it is plausible that better teaching results in better-qualified pupils, who finish secondary school earlier and who are more likely to continue their education. But it is also possible that lower pupil-teacher ratios are picking up some omitted household or geographical characteristic associated with a preference for education.

4.4 Determinants and effects of test scores

We turn now to the much smaller sample of individuals who took the comprehension and numeracy tests appended to the main survey. Since the selection of the adult sample of test-takers was problematic, and since the pupil-teacher ratio can only be reliably linked with those now in school, we confine our attention to those between 13 and 18 years of age, of which there are 763 Blacks, and 89 Whites. The samples of Asians and Coloreds are too small for separate analysis, and we do not feel justified in pooling them with either of the other two groups.

The results for the White subsample are presented in the first two columns of Table 4.4; there are no significant effects of any of the variables on either of the two scores. While this is consistent with the general lack of such findings in the literature, the small sample size must be kept in mind; the estimated effects of the pupil-teacher ratio are insignificantly different from zero but are also consistent with the existence of a large negative influence of class size on test scores. For the larger sample of Black adolescents, the results are more precise. Columns (3) and (4) show the regressions with education omitted, columns (5) and (6) with years of completed education as a conditioning variable, and columns (7) and (8) with education included but without the family background variables. Since pupil-teacher ratios affect the amount of education, which in turn is likely to affect

test scores, we are interested in regressions both unconditional and conditional on education. The conditional regression measures the direct effect of educational quality on tests scores with quantity held constant, while the unconditional regression gives the total (reduced form) effect of quality, both direct and indirect. In the absence of education, age has a positive effect on test-scores, as does the education of the household head, household resources and female headship. Higher pupil-teacher ratios negatively affect both scores, but the size of the effect is five times as large for the mathematics test scores as it is on the comprehension scores. The standard errors are much the same for both, so that only the effect on the math score is significantly different from zero.

Columns (5) and (6) include educational attainment as a regressor, which has a strong positive effect on test scores—four additional years generates one additional correct answer on the tests—and which removes the effect of age. The estimated coefficients of pupil-teacher ratios are diminished (absolutely) by the exclusion of the indirect effect on educational attainment; there is no estimated direct effect of the pupil-teacher ratio on the comprehension score, and the reduction in the size of the effect on the math score leaves it significant only at the 10 percent level. The comparison between these results and those in the final two columns shows that the results are robust to the inclusion or exclusion of the background variables. In their absence, the pupil-teacher ratio has somewhat larger effects, and is more precisely estimated, but the difference is not very marked.

Table 4.5 looks at the effect of facilities other than pupil-teacher ratios. We work here with Black adolescents only, and the samples are further reduced (and likely selected) by the problems with SALDRU2. We show the regressions with years of education included—the results are similar with the expected alterations if education is excluded—as well as the family background variables, though these are not shown in the Table. We focus on three measures of facilities, whether the local primary

Table 4.4 Determinants of Literacy and Numeracy Test Scores

	WHITES		BLACKS		BLACKS		BLACKS	
	Literacy	Numeracy	Literacy	Numeracy	Literacy	Numeracy	Literacy	Numeracy
Years of Completed Education	.225 (1.5)	-.052 (0.3)	--	--	.225 (7.7)	.270 (8.7)	.273 (9.8)	.300 (10.2)
Age	.091 (0.5)	.355 (1.8)	.161 (4.6)	.146 (3.9)	.024 (0.6)	-.019 (0.5)	-.006 (0.2)	-.037 (0.9)
Log (Pupil-Teacher Ratio)	1.15 (0.6)	3.24 (1.4)	-.156 (0.5)	-.778 (2.2)	.006 (0.0)	-.584 (1.7)	-.123 (0.4)	-.825 (2.5)
Female	.264 (0.7)	.262 (0.6)	.067 (0.5)	-.051 (0.4)	-.041 (0.3)	-.181 (1.4)	-.047 (0.4)	-.145 (1.2)
Head of Household's Completed Educ	.078 (1.4)	.055 (0.9)	.072 (4.3)	.078 (4.3)	.053 (3.2)	.054 (3.1)	--	--
Log (Household Size)	1.25 (1.6)	.424 (0.5)	.186 (1.2)	.109 (0.7)	.143 (1.0)	.017 (0.4)	--	--
Indicator: Female Head	-.164 (0.2)	-1.24 (1.4)	.205 (1.6)	.324 (2.4)	.169 (1.4)	.281 (2.2)	--	--
Log (Expenditure per Household Member)	.569 (1.3)	.824 (1.7)	.392 (3.7)	.318 (2.8)	.231 (2..2)	.125 (1.1)	--	--
R^2	.200	.251	.132	.122	.125	.203	.175	.183
Number of Obs	89	89	763	763	763	763	777	777

SOURCE: SALDRU1 and SALDRU3. All regressions include metro indicators.

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school has a library, whether the secondary school has a library, and whether the secondary school has a laboratory. We selected these because they are the most likely to have a direct affect on the test scores, though we recognize that they are also likely to serve as indicators of the general quality and endowments of schools. In the first six columns of the Table, each facility is entered in turn and, in the last two columns, jointly; the last regressions do not subsume the first three pairs because the sample is different for different facilities. All regressions contain the pupil-teacher ratio from the Atlas.

The effects of the pupil-teacher ratios on test scores are not different from the results in Table 4.4. Higher pupil-teacher ratios reduce the math score but have little or no effect on the comprehension scores. We find no effect of a primary school library, but the presence of a secondary school library has a significant and large— half a correct answer—influence on the literacy test score. Secondary school laboratories have no effect when entered on their own, and a negative effect when entered jointly, but note the enhancement of the library coefficient and the high correlation between secondary school facilities.

Although the evidence here cannot be given much weight—the sample sizes are small and many clusters are excluded for reasons that we do not understand—the results are consistent with the common sense view that the provision of facilities—in this case a library—enhances the related skill, and does so in addition to the effects of class size.

4.5 Returns to the quantity and quality of education

We turn last to the important question of why we should be interested in test scores. Although scores are an immediate and direct measure of educational attainment, we are much more interested in the

Table 4.5: School Facilities and Test Scores
Blacks Only

	Literacy	Numeracy	Literacy	Numeracy	Literacy	Numeracy	Literacy	Numeracy
Primary School Library	-.122 (0.5)	.064 (0.2)	--	--	--	--	-.361 (1.3)	-.304 (1.0)
Secondary School Library	--	--	.566 (3.1)	.044 (0.2)	--	--	.860 (3.9)	.398 (1.7)
Secondary School Laboratory	--	--	--	--	-.040 (0.2)	-.174 (0.9)	-.452 (2.1)	-.366 (1.6)
Years Completed Education	.243 (6.7)	.316 (8.2)	.281 (6.7)	.328 (7.1)	.274 (6.4)	.322 (6.9)	.261 (6.1)	.332 (7.1)
Age	-.005 (0.1)	-.063 (1.3)	-.040 (0.8)	-.067 (1.2)	-.030 (0.6)	-.065 (1.1)	-.034 (0.7)	-.079 (1.4)
Log(Pupil-Teacher Ratio)	-.468 (1.4)	-.822 (2.2)	.360 (0.8)	-.893 (1.9)	-.124 (0.3)	-1.04 (2.3)	.248 (0.6)	-.938 (2.0)
Number of Obs	523	523	392	392	392	392	383	383
F-test: Joint significance of libraries and laboratories							5.49 (.001)	1.51 (.212)

Notes: Data are from the 1993 SALSS survey.
T-statistics reported in parentheses. Also included in the regressions are: indicator female respondent, household head's years of completed education, log(household size), log (total expenditure per household member), an indicator for female head of household, and rural and urban indicators.
Results are qualitatively and quantitatively similar if one does not control for years of completed education.

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ability of the educational system to generate human capital, something that is best measured not by test scores, but by success in the labor market. The data used in this paper are not well-suited to measuring the ultimate effects of educational quality; we do not know where the adults in the SALSS were born, let alone where they were educated. In future work, we plan to use census data and historical administrative records to link educational spending to educational outcomes, but we have not yet done the substantial amount of research that is necessary to establish such a data base. For the moment, we can do no more than present some rather fragmentary and unsatisfactory evidence on returns and on the links between test scores and market outcomes.

The first column of Table 4.6 shows a standard regression of the logarithm of the hourly wage on years of education. This was constructed so as to be (an approximate) replication of the results in Mwabu and Schultz (1996), henceforward MS. To the extent that we were able, we have followed the construction of variables in MS, and our means and sample sizes are close (although not identical) to theirs. Our regression omits some of their variables, such as the whether or not the cluster has a tarred road from SALDRU2, and we make no attempt to use the information on assets to construct a Heckman selectivity correction, which in any case has little effect on the results in MS. In any case, the results in this column are very similar to theirs. For Blacks we estimate high returns to additional years of secondary and tertiary education. It is interesting to note that this is the opposite of what was observed in the American South during segregation where the lower quality of black schools was an oft-cited reason for the *lower* returns to Black as opposed to White education, see Card and Krueger (1992*b*.)

Table 4.6: Test Scores and Wages, Incomes and Household Expenditures
Black Adults

	Dep Var: Log(average hourly earnings)	Dep Var: Log(average hourly earnings)	Dep Var: Log(average hourly earnings)	Dep Var: Log(average hourly earnings)	Dep Var: Log(Total Income)	Dep Var: Log(Total Expend)
Literacy Score	--	.063 (2.24)	--	.022 (0.56)	.059 (2.59)	.079 (5.31)
Numeracy Score	--	--	.074 (2.64)	.058 (1.47)	.036 (1.56)	-.011 (0.72)
Female	-.474 (20.83)	-.552 (5.15)	-.577 (5.42)	-.569 (5.30)	--	--
Age	.076 (10.68)	.072 (1.74)	.078 (1.88)	.077 (1.87)	--	--
Age^2	-.001 (9.01)	-.001 (1.23)	-.001 (1.45)	-.001 (1.43)	--	--
Primary School Years of Ed	.059 (11.26)	.035 (1.23)	.030 (1.04)	.029 (0.99)	--	--
Secondary School Years of Ed	.148 (19.74)	.112 (3.07)	.121 (3.48)	.115 (3.17)	--	--
Tertiary School Years of Ed	.297 (14.99)	.409 (5.64)	.391 (5.39)	.394 (5.40)	--	--
Head of Household's Completed Ed	--	--	--	--	.065 (7.57)	.043 (7.80)
Indicator: Female Head of Household	--	--	--	--	-.426 (5.89)	-.217 (4.61)
Number of Obs	3949	147	147	147	809	829
F-test: Literacy and Numeracy Scores				3.63 (.0292)	14.84 (.0000)	23.22 (.0000)

Notes:
T-statistics are reported in parentheses. Average hourly earnings are defined as regular sector net cash payments plus subsidies for transportation, food and housing divided by the estimated number of hours worked per week plus any reported annual bonus divided by the estimated number of hours worked per year. Hours worked per week are estimated as the respondent's reported regular hours per day times the number of days worked for the respondent's reported pay type. (Following Mwabu and Schultz, we assign days worked by pay periods: weekly = 5.4 days; fortnighly = 10.8 days; monthly = 21.7 days.) Hours per year are estimated as: 52 × 5.4 × reported regular hours per day. Urban and rural indicators included in all regressions. Also included in columns (4) and (5) are household size and household composition variables: number of members aged 0-5,6-15,16-18,19-21,22-24, males 65 and older, and females 60 and older.

If these estimates are accepted, they provide one immediate measure of the effect of spending more money on teachers. Lower pupil-teacher ratios increase the amount of education which in turn generates higher earnings. To return to the earlier example, a decrease in pupils per teacher of 10—which would eliminate about half the gap between Blacks and other students—would add about a quarter of a year of education for each pupil, with an associated increase in earnings of 2–4 percent depending on the split between primary and secondary years. If we make enough assumptions, we can also use these figures to give some idea of the rate of return. We work from a pupil-teacher ratio of 40, and assume that a teacher instructs a given pupil for 10 years who then earns for 40 years. At a real interest rate of 6.8 percent, one rand spent for ten years has the same present value as one rand received for forty years from years eleven to fifty, and we work with this rate for simplicity. If we take the effect of the pupil-teacher ratio on years to be –0.30 (Table 4.1) and the rate of return to an additional year as 14 percent (Table 4.6), then the net present value of an additional rand invested in a teacher is 5.22 divided by the relative earnings of teachers to pupils, or the number of years of pupil's earnings it takes to pay and equip an additional teacher. This calculation will be an overstatement if—as is the case in South Africa—a large fraction of individuals are unemployed, though there is presumably some return to education even for the unemployed. The calculation understates the returns in that it makes no allowance for any direct effect of school quality on earnings, only for the indirect effect through years spent in school. It is hard to be more precise without further information, but it seems that unless teachers are quite costly, additional teachers for Black schools are likely to be a good investment.

Table 4.6 also provides some (very poor) evidence on the link between test scores and earnings.

Columns (2), (3) and (4) show regressions of the logarithm of hourly earnings on years of education including the two test scores, separately and jointly. This regression uses the data on the test scores for the *adults* in SALDRU3, and as we have seen, these are predominantly women who have low attachment to the formal labor force. As a result, the sample size falls to only 147—as opposed to 3,949 in the first column—and those 147 are so selected as to be almost worthless for making general inferences. Even so, the patterns of returns to education are not very different from those in the first column. The test scores are individually significant when entered separately, and jointly significant when entered together; note again the positive correlation between them. These results are a little different to those reported by Moll (1995), whose regression differs from ours only in detail, but who finds a positive effect for the numeracy score but none for the literacy score.

In an attempt to escape from the small sample of people who have both regular earnings and test scores, we report in Columns (3) and (4) regressions of the logarithms of household total income and household total expenditure on the education of the household head and on test scores. The literacy scores—but not the math scores—have strong predictive power in these regressions, which is consistent with better skills enhancing income in general. Of course, such results are just as open to alternative interpretations, that people with more resources buy better quality education, or that there are unmeasured determinants of economic success that are correlated with test scores.

5. Summary and conclusions

On the eve of democratic elections in South Africa, as remains the case today, educational resources were (and are) sharply different by race, with pupil-teacher ratios in Black schools more than twice as high as those in White schools. In this environment, we find that high pupil-teacher ratios

discourage education attainment conditional on age, lower test scores, lower the probability of being enrolled in education, and discourage parents from making complementary expenditures on their children's education. The results for educational attainment, enrollment, and expenditures are based on a large sample of pupils and schools; those for test scores on a much smaller subsample. The effects of the pupil-teacher ratio on attainment and enrollment are confined to Blacks, consistent with the view that at the small class sizes that characterize education for the other racial groups, reductions in class size have little or no effect. The differential consequences of public resources for the education of Whites and Blacks is mirrored in the results for private resources. Pupils in better-off Black households do better in their education, and we find no parallel for Whites. That the education of Blacks but not Whites is constrained by financial resources is further supported by the fact that many Blacks who are not in school—but no Whites— report lack of resources as the reason.

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