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Stellenbosch Economic Working Papers: 16/07

KEYWORDS: EDUCATION QUALITY, INEQUALITY, SOUTH AFRICA, SOUTHERN AFRICA,
HIERARCHICAL LINEAR MODELLING
JEL: I21

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A WORKING PAPER OF THE DEPARTMENT OF ECONOMICS AND THE
BUREAU FOR ECONOMIC RESEARCH AT THE UNIVERSITY OF STELLENBOSCH

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ABSTRACT

In regional context, South African students benefit from above average levels of public and private education resources. However, their performance on international tests – including SACMEQII (Southern African Consortium for Monitoring Educational Quality, 2000) – is extremely weak. The first part of the paper positions South Africa within southern and eastern Africa on the basis of SACMEQII Grade 6 mathematics test scores. Hierarchical linear modelling techniques are then employed to model the relationship between socio-economic status (SES) and schooling in this highly unequal country. Three important drivers of inequity in test scores emerge: principal concern with monitoring student progress, teacher absenteeism and teacher quality. These interact with SES to give richer students a strong advantage.

Keywords: Education quality, inequality, South Africa, Southern Africa, hierarchical linear modelling

JEL codes: I21

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Introduction

In regional context, South Africa is well resourced. Its per capita income (adjusted for purchasing power parity) currently ranks third out of the 14 countries¹ surveyed in 2001 for the second wave of the SACMEQ (Southern African Consortium for Monitoring Education Quality) study (World Bank 2004). Further, public spending on education currently constitutes the single largest government budget line item, accounting for approximately 6 per cent of GDP (Republic of South Africa, National Treasury 2004). Given the relative abundance of private and public resources, educationists and economists alike might be forgiven for predicting that South Africa's educational outcomes are amongst the best in the region.

This is a far cry from the truth, however. Research shows that the test scores obtained by South African students on international tests are much lower than those obtained by their French counterparts – whose government spends a similar proportion of GDP on education – as well as students in the East Asian tigers of Hong Kong, Singapore and South Korea, all of which have governments that spend proportionately much less on schooling than the South African government (Crouch and Fasih 2004). This suggests that the South African schooling system may fare poorly in the efficiency with which it converts resources into student outcomes. If comparisons with more developed countries are considered somewhat misleading, it should be noted that the relative ranking of South Africa's schooling system does not improve when placed in regional context. Ross and Zuze (2004) point out that the quality of schooling received by South African students is below the regional average once cross-country differences in SES (socio-economic status) have been controlled for². These authors also find that South Africa's schooling system fares dismally in promoting social equity – implying that students of a low SES are at a greater disadvantage than those in most of the other SACMEQ countries – as well as distributional equity: the variance in South African reading test scores is almost double the SACMEQ average variance. Such findings are in line with the argument that cross-country resource differentials do not explain cross-country student performance differentials very well, given the varying ability of schooling systems to transform inputs into student performance (Woessmann 2003).

¹ Strictly speaking, only 13 countries are surveyed. Zanzibar, which is semi-autonomous, was surveyed separately from mainland Tanzania, its partner in the federation.

² Ross and Zuze (2004) define high school quality as high values of predicted mean student achievement for a level of student socio-economic status equivalent to the average for all national schooling systems included in SACMEQII.

The weakness of South Africa's performance on the SACMEQ tests, in terms of both efficiency and equity, prompted a further investigation into the factors driving the production of educational outputs in this country. In executing this task, the impact on student performance of factors comprising family background and those describing school process and organization – the latter collectively determining school quality – are considered. Previous research by Van der Berg (2005), Van der Berg and Louw (2006) and Louw, Van der Berg and Yu (2006) collectively forms the backbone for these three sections, with hierarchical linear modelling (HLM) selected as the major methodology utilized for original analysis. The point of departure for modelling here is a previous finding that average school SES affects individual achievement disproportionately much as student SES rises (Van der Berg 2005; Van der Berg and Louw 2006). This paper unravels the relationship between student and school SES through examining the effect of teacher quality and school management variables. It explains the relationship through evaluating the impact of principal priorities, teacher absenteeism and teacher quality. Results indicate that more information on student performance as well as attention to quality assurance and accountability procedures may be cost-effective ways of improving the quality of schooling offered in South Africa.

1. The impact of family background on student performance

2.1 Defining the relationship between family background and educational outcomes

There is a well-established literature regarding the impact of family background on schooling outcomes, with South African applications provided amongst others by Burns (2001), Lam (1999) and Louw, Van der Berg and Yu (2006). At least two channels of family background influence can be identified: parents' education and private household resources. While these are often grouped together to indicate a student's socio-economic status (SES), this paper will treat them separately, defining SES in terms of the household's physical resource base. Doing so allows one to identify to what extent parents' educational attainment limits or promotes their children's schooling outcomes, i.e. to determine the extent of intergenerational educational mobility. This is of particular interest in South Africa, where members of other race groups were at a disadvantage vis-à-vis whites in terms of schooling during the apartheid era.

The way in which private household resources affect children's educational performance is relatively straightforward to identify. Access to more resources implies potentially greater household support for learning in the form of funding school fees, transport to school, school uniforms, investment in child health (for example through nutrition), educational materials and supplementary private tuition. If households were not credit constrained, i.e. if they were all able to obtain as much credit as they required at the prevailing interest rate, then the material position of an individual household should

not constrain its investment in education. However, in developing countries, this is an unrealistic assumption. Case and Deaton (1999) show that household income influences the educational attainment of black students, but not that of their white counterparts; this is consistent with Gormly and Swinnerton's (2003) finding that liquidity constraints operate for the less affluent 95 percent of the South African population. Secondly, affluent parents are likely to be members of affluent social networks, which may provide their children with superior labour market prospects upon completion of their schooling.

Quantifying the role of parents' education in children's schooling performance is slightly more difficult. Better-educated parents may rank education more highly as a household priority, and thus be willing to devote more money, time and other resources to their children's schooling. This may include choosing to live in neighbourhoods with better schools, thus providing their children with superior schooling opportunities. Secondly, one might expect them to complement the teaching received by their children more effectively, for example through providing better help with homework (Behrman et al. 1999). Finally, well-educated parents may affect the quality of schooling that their children receive directly by being better informed about education issues and more actively participating in school management. In the South African context, Case and Deaton (1999) find positive effects of parents' education on the educational attainment of both black and white children; by their estimates, a student living in a household where the head has completed secondary education is predicted to progress approximately one third of a grade per year more than his or her counterpart living in a household headed by an adult who has only completed primary schooling. Thomas (1996) makes similar findings: black and Indian children's educational attainment rises by 0.3-0.4 years for each additional year of maternal education; the effect is smaller for white and coloured children (approximately 0.2). The present paper shows later that the relationship between learning and parents' educational attainment is likely to be non-linear in the South African case, increasing with the level of a parent's education³.

2.2 Intergenerational mobility and equity

³ It should be borne in mind, however, that typically estimates of the impact of parents' education on their children's schooling outcomes are upwardly biased in empirical analysis, given that ability is generally not measured. Econometric theory dictates that the existence of a positive correlation between an omitted relevant variable and one included as an explanatory variable results in the coefficient estimate for the latter being upwardly biased. The tendency to overstate the effect of parents' education arises as a result of possible intergenerational transfer of ability and assortative mating (the latter referring to individuals of similar ability and educational status pairing), implying that there is likely to be a positive correlation between the ability levels of parents and those of their children.

The preceding discussion has important implications for determining equity in schooling outcomes. While the government has focused a significant amount of attention on promoting equity across the reunified schooling system over the past decade (inter alia through equalising teacher salaries and PTRs (pupil-teacher ratios), and providing preferential non-teacher funding to schools of low SES), intergenerational persistence in SES and education will limit the extent to which the majority of students currently in the schooling system are able to escape the historical disadvantage they bear, given their parents' low educational attainment. In South Africa there is a strong relationship between an individual's level of education and his or her standard of living, given that unemployment rates are strongly positively related to education levels (Bhorat 2003), and that those with tertiary qualifications are able to command a substantial premium in the labour market (Keswell & Poswell 2002). Consequently, it is of particular interest to assess the degree of intergenerational *educational* mobility experienced by South African students.

Louw, Van der Berg and Yu (2006) examine the issue of intergenerational educational mobility in South Africa in more detail, tracking changes since 1985. The table below shows a pattern of increasing educational attainment between 1985 and 2001 for black and coloured youth, the two groups with historically lowest schooling. Note that by 2001, inequality in educational attainment amongst 16-20 year olds of different race groups had substantially declined. However, this masks the massive variation in the quality in schooling received by children belonging to different race groups, which forms the topic of discussion in a later section of this paper.

Turning to more formal analysis, Louw et al. (2006) consider trends in both absolute and relative social mobility⁴. The former is linked to the level of economic development, as it will reflect a rise in average educational attainment caused by a policy-driven expansion of schooling. The latter highlights differentials in access to opportunity within society, and is thus not influenced by the level of socio-economic development.

To evaluate absolute social mobility, an intergenerational schooling mobility index constructed by Behrman et al. (1998) was calculated for 10-21 year olds for the years 1991 and 2001. A large increase in mobility became evident for all black age cohorts within the broader age span over the 1990s, with evidence of a substantial increase in mobility for coloureds in the 10-15 year old age group as well. It seems that the mobility of coloured children in higher grades is limited by historically high dropout rates from age 15 onwards, perhaps due to their relatively favourable employment prospects (a larger proportion live in and around a metropolitan area, where labour market conditions are better). Further, the indices for the total population show less mobility than the

⁴ Social mobility takes into account the effect of both parents' education and SES on a child's educational attainment.

indices for individual population groups. One explanation is that the indices for the total population span a broad range of levels of social mobility associated with the different race groups comprising the total group aged 10-21, while levels of social mobility within race groups are less variable. Placing South Africa in international context reveals that it performs relatively favourably regarding schooling mobility vis-à-vis comparable Latin American countries. The intergenerational schooling mobility index for South Africa for 2001 is roughly comparable with those of the country that is most socially mobile by this measure – Chile – for 1994⁵.

As mentioned above, relative social mobility measures are not sensitive to changes in average educational attainment. This implies that if all of the observed increase in mobility reflected in the intergenerational schooling mobility index was due to government's schooling push, then little change in relative social mobility would have been observed over the past two decades. To measure relative social mobility, the sibling correlation index of Behrman et al. (2001) is computed for 16-20 year olds for the years 1985, 1991 and 2001; for further details, see Louw et al. (2006). The results indicate an increase in mobility for blacks and coloureds between 1991 and 2001, and a decrease in mobility for whites. While the increases in mobility for blacks and coloureds are clearly encouraging, one might be tempted to believe that the reduction in mobility is prejudicing whites. In fact, the opposite is true: it implies that white children will be more likely to enjoy the high socio-economic status of their parents. Calculating aggregate measures of relative mobility and turning to international comparisons, South Africa ranks alongside the Latin American countries that score best on the sibling correlation index, such as Paraguay. Note that South Africa fares substantially better on both this index and the intergenerational schooling mobility index than does Brazil, a country with which it is frequently compared.

Finally, consider that mother and father's education may impact differently on children's schooling outcomes. In the international literature, it is common to find that mother's education is more important for children's schooling (Thomas 1996). Using Census data for 1991, Thomas (1996) found roughly similar effects of mother's and father's education in South Africa⁶. The exception arose in the black population: the impact of a black mother's education on her daughter's schooling was significantly larger than that of the daughter's father.

2. The impact of school quality on student performance

Despite the intuitive importance of school-related factors for student performance, finding empirical support for them is notoriously difficult. Eric Hanushek (1986; 2004) points out that schools and

⁵ This is the latest year for which index values for Chile are available from Behrman et al. (1998).

⁶ Lam (1999) corroborates this finding with his research on the October Household Survey of 1995.

classrooms with access to superior resources do not necessarily provide the best quality education. At the heart of this problem lies an issue of efficiency: schools translate inputs into outputs with varying degrees of efficiency, with many – particularly in developing countries – operating well within the efficiency frontier (Glewwe 2002: 436). This suggests that conventional, easily quantifiable measures of school quality may not be the correct ones for explaining the role of schooling processes in the education production function.

The pupil-teacher ratio (PTR) is one of the most commonly used measures of factors influencing school quality. However, smaller classes may produce better results for a number of reasons other than through providing students with better education. Parents of more able children may attempt to ensure that they are placed in smaller classes; similarly, parents of greater affluence or who place greater value on education may agitate for higher levels of school funding. In the South African case, Case and Deaton (1999) sidestepped this problem by conducting their analysis shortly before the end of apartheid, when highly centralised school funding decisions and legislatively restricted mobility and schooling options prevented members of different race groups from exercising much choice in school selection and management. At that time, PTRs were on average much higher in black schools than in white schools, and also substantially more variable. The authors found that the PTR had a significant negative relationship with educational attainment for black students, while there was no similar finding for whites.

Following the political transition, the Department of Education moved to equalise PTRs across the reunified schooling system, aiming at levels of 34 for primary schools and 37 for secondary schools. As a result, PTRs have fallen in historically black schools although they remain much higher in these schools than in historically white schools. One part of the explanation for this ongoing disparity lies in the hiring of school governing body (SGB) teachers by affluent historically white schools. Furthermore, historically black primary schools react less strongly in terms of increasing teacher staff complements when student numbers increase (Yamauchi 2005). Part of the explanation may involve the location of many of these schools. Schools in rural areas – despite having no worse access to teacher funding – often experience difficulty in filling posts due to the reluctance of teachers to relocate to remote areas. As a consequence, in 2000 approximately 20 per cent of grade six students in rural areas were taught by mathematics teachers with degrees, compared with more than double that number in urban areas.

Despite these rural-urban differentials, however, collectively South African students are relatively well off in regional context. Table 2 shows that South Africa's pupil-teacher ratio is much more favourable than the SACMEQ mean, and that three of the countries outperforming South Africa in terms of mathematics scores (Mozambique, Tanzania and Uganda) have much less favourable ratios.

In addition, the proportion of students in South Africa taught mathematics by a teacher with A-levels or a degree is exceeded only in Seychelles and Swaziland.

Unfortunately, having a favourable pupil-teacher ratio and well-qualified teachers does not necessarily imply that South African education is amongst the best in Southern and Eastern Africa. The potential learning benefit associated with drawing on relatively good teacher resources is likely to be limited by how well teachers are managed by the schools in which they are employed. Indeed, an growing awareness of related issues has led to school management receiving an increasing amount of attention in the education policy debate in South Africa. Research shows that schools in this country transform inputs into outputs with a large degree of variation, and that some low SES schools perform well above their predicted levels in spite of being at a resource disadvantage (Crouch and Magoboane 1998). This suggests that managing the available resources well rather than benefiting from a greater stock of resources may be the most critical school-level determinant of student performance.

Many ascribe the poor performance of the school system to the large number of schools that are largely dysfunctional (Taylor 2006). This leads to a situation where greatly varying levels of learning within the same classroom has become the norm, making the task of teaching even more difficult. Thus, for instance, using the SACMEQII dataset, Moloi (2005) from the Department of Education found that more than half of grade 6 students perform at a grade 3 level or lower in mathematics. The effect of dysfunctional schools may completely swamp the possible positive effects of teacher or student efforts. At the classroom level, there is generally insufficient monitoring and feedback of student performance, which means that obstacles to academic progress are often not clearly revealed and that corrective action is not taken. Economists seek the answer to such a problem – which is quite common in bureaucratic systems – in more information: both for students (monitoring reduces uncertainty regarding ability to meet relevant academic standards) and for parents (publicly available information regarding performance of schools allows parents to participate in school management more actively and effectively, as well as to select the best option available for their children).

Extremely high variation in the efficiency with which South African schools function has resulted in student performance being largely determined by school choice. In fact, the intra-class correlation coefficient ρ indicates that a striking 64 per cent of the variation in South African student SACMEQII numeracy test scores can be attributed to school-level differences in performance. This is by far the highest figure amongst the countries included in the SACMEQ study. The point is illustrated further by analysing South African matriculation marks. For entrance to most commerce- or science-related degree programmes, universities typically require matriculants to obtain a minimum of 60 per cent on higher grade mathematics or alternatively 70 per cent on standard grade. In 2003,

only 7 538 out of a matric-aged cohort of almost one million qualified by this measure in public schools. Of these, three-quarters came from 10 per cent of the public high schools.

3. Empirical analysis

As mentioned above, finding suitable measures of school quality is no easy task. It is made even more difficult in the South African context, where there is a large degree of heterogeneity in the training of teachers themselves as a result of historical racial divisions in the education system. The impact of this legacy on standard teacher quality measures – such as years of education or type of tertiary qualification – has been large enough to frustrate many previous investigations into the link between teacher quality and student performance. Furthermore, the otherwise useful alternative SACMEQII teacher quality measure – teacher test score – cannot be used in analysis on South African data, as opposition to teacher testing led to this part of the survey not being undertaken in South Africa. Even the PTR is no longer expected to be a strong indicator of school quality as a result of the declining variation in this measure, although the presence of SGB (school governing body) teachers in more affluent schools means that the relationship between school SES and the PTR has been strengthened. To complicate matters further, the SACMEQII sum of teachers variable includes temporary and part-time teachers; without additional information on the nature of such posts, it is impossible to estimate how many hours per week these teachers are engaged in teaching activities. Consequently, one would expect the PTR to be a noisy and rather uninformative measure.

Modelling the role of school quality in student performance in this paper thus departs from a slightly different angle than the one conventionally adopted. The hypothesis here is that since school quality varies positively with a student's family background, given the historical link between the affluence of a community and the quality of schooling offered, these two sets of factors may interact in producing individual schooling outcomes. The authors' previous work (Van der Berg & Louw 2006) shows that the effect of individual SES on student performance on the SACMEQII numeracy test is non-linear, as Figure 1 shows. Analysing the data reveals that there is no clear relationship between test scores and individual SES for the poorest 60 per cent of South African students (of whom the vast majority are black). This suggests that the majority of students attend schools that are so dysfunctional and inefficient that individual measures of school quality are unlikely to improve student performance. By contrast, there is a relatively steep positive relationship between SES and student performance for the two most affluent student quintiles, suggesting that school quality may matter greatly – potentially in measurable ways – for these children.

Placing the mathematics performance of South African grade six students in regional context reveals how poorly SES is transformed into schooling outcomes in this country. Only Zambia, Swaziland and

Namibia perform worse than students in the poorest three South African quintiles (see figure 2). However, note that even the performance of the most affluent South African quintile is not particularly impressive; the Mauritian students of equivalent or better SES (i.e. those in the two most affluent quintiles) outperform this group. Even more disturbingly, the most affluent student quintile in Kenya outperforms the most affluent South African quintile (quintile 5), despite the fact that they are from backgrounds less affluent than the average for the South Africa's second most affluent quintile (quintile 4).

The observed lack of relationship between student SES and learning for the poorest 60 per cent of South African grade six students is especially troubling in light of the fact that South African student and school SES are highly correlated – and most extremely so in the poorest three quintiles – relative to the other SACMEQ countries. This suggests that poor students face a real possibility of being trapped in a vicious cycle between low quality education and poverty, since they are concentrated in schools with equally poor children. These children may thus find themselves. Consequently, the educational system may reinforce the existing stark inequality of access to opportunity by strengthening the dividing lines drawn by socio-economic class.

For purposes of formal empirical analysis, hierarchical linear modelling (HLM) is used. This methodology is frequently adopted in educational analysis since it is well suited to modelling nested data structures; student performance can be modelled on two or three different levels. In this paper, mathematics test scores are modelled at both the student and school levels to assess the influence of household factors (including family background) and school quality, respectively, on student performance. While discussion of the empirical model in this section is non-technical in nature, the interested reader is referred to the appendix for a more technical treatment.

The results of modelling are contained in Table 3. How does this empirical analysis contribute to an understanding of the learning process? Firstly, it allows one to consider two channels of influence for student SES on test scores. HLM model (1) explains the impact of student SES through school average SES. The simplest way to think about this is in terms of interaction between school SES and student SES; the benefit associated with being in an affluent school increases disproportionately as student SES rises. Put differently, both poor and rich students are likely to perform better in richer schools, but rich students gain more from the superior quality of education offered in such schools. This reflects the non-linear relationship between student SES and test scores plotted above in Figure 1. While such a finding may tempt one to conclude that affluent schools promote inequality in outcomes, in reality this finding reflects the weak relationship between schooling inputs (including SES) and student performance in poor schools. Model (2) takes the analysis one step further, as individual school-level factors are added to the model to explain the observed relationship between

school SES and student SES⁷. This second specification forms the focus of this paper, and is discussed in more detail below.

Apart from SES, parents' education is another factor that theory predicts to be an important determinant of test performance. Students with mothers in possession of tertiary qualifications are at a modest – and statistically not highly significant – advantage relative to others; however the positive influence of parents' education on schooling does not extend to mothers with only secondary education, i.e. it is non-linear. This raises an interesting (and rather disturbing) issue: the education of parents with secondary schooling or less does not appear to positively affect children's learning. This is corroborated by research that shows that in international context, SA under-performs on learning given access to schooling in this country during the 1970s: the decade in which the previous generation would have obtained education (Crouch and Fasih (2004)). In part at least, one may attribute this to the legacy of apartheid. Parents educated in the historically disadvantaged parts of the schooling system in the apartheid period may provide their children with little school preparation and learning support, or alternatively place low value on education when allocating household resources. This is understandable given the persistently weak schooling offered in many parts of the schooling system, which reduces future payoffs to schooling in the labour market (Case & Yogo 1999).

Interestingly, household resources devoted to cognitive development turn out to be important for test performance: these comprise an item index reflecting the quantity of stationery owned by a student as well as a dummy variable indicating that a household possesses more than 10 books. Such variables may indicate the value the household places on education rather than SES per se. Note that there is also a performance advantage of 10 points for students who stay with their parents, indicating that the extent to which students benefit from household factors depends on the biological relationship they have with their caregivers. This links in with research showing that black South African children living with both genetic parents had the best schooling outcomes while those living with neither genetic parent had the worst outcomes (Anderson 2000). At least in part, this could be traced to their education being a lower household budgetary priority: expenditure on school fees and transport was lower for children living with neither genetic parent. The education disadvantages of not living with both genetic parents include both a lower probability of enrolment and a greater likelihood of slow progression through school (Anderson 2000).

Turning to the variables that describe a student's attendance and progression through schooling, note first that there are test score penalties for having repeated grades, rising with the number of grades repeated. Similarly, there is a test score penalty for being overage (defined here as being 13 years or

⁷ School average SES is no longer included as an explanatory variable, since it is not statistically significant at the 10 per cent level once the other variables are added.

older in grade 6); note that this effect operates over and above the adverse effect of grade repetition. It is likely to indicate the effect of interruptions to schooling – in the form of dropping out of and then re-entering the schooling system – on learning. Furthermore, children who lag behind tend to suffer from lower spending on school fees, transport to school and other school expenses (Anderson et al. 2001: 5). This may reflect that learning is assigned a low value in their households. Student absenteeism also (unsurprisingly) has significant negative effects on performance: this depends both on the extent and the reason for absenteeism. There is a small test score penalty for each day per month that a student is absent as well as a large test score penalty – 13 points – for being absent due to outstanding school fees, which may in part be an indication of lack of parental support for education.

There are also three sets of student-level controls. The first set relates to language spoken outside school; observe that there are considerable benefits attached to speaking English either sometimes or all of the time, with the effect of the latter being larger. While these indicators may reflect that a student is better equipped to understand and answer the SACMEQ numeracy test, the race groups with the largest proportion of English speakers (Indians and whites) historically also have attended better quality schools. Secondly, including a gender dummy indicates that there are no significant gender differences in performance once other factors have been considered. Finally, province dummies indicate that students in all provinces except KwaZulu-Natal perform significantly worse than those in the Western Cape, the reference province.

Next, school-level factors are analysed. These are factors that raise or lower the performance of all children in a school. Beginning with the intercept, note that at a level of just over 500, it is approximately equal to the SACMEQ mean (500). The reliability of the intercept estimate is high (0.86), indicating that the model has a strong ability to explain the impact of school characteristics on average student achievements; in other words, it supports the hypothesis that schools are important for determining student achievement. Variables that affect the intercept negatively are:

- A principal-reported teacher absenteeism problem. This negative effect is very large (around 82 point test score penalty) and highly statistically significant. It most likely indicates schools that remain dysfunctional due to their apartheid legacy. Indeed, Figure 3 shows that teacher absenteeism is particularly widespread in the less affluent parts of the schooling system, but note that a substantial proportion of schools in the most affluent quintile (26 per cent) report experiencing the same problem;
- A student absenteeism problem, as measured by the average of the number of days students report having been absent during a month. This may also be evidence of the abovementioned problem. It stands to reason that schools where teachers and students are frequently absent, are not well functioning institutions;

- The proportion of students that have repeated grades three times or more. As in the case of the previous two variables, to some extent this also likely indicates dysfunctional schools. However, the coefficient on this dummy variable is only marginally statistically significant.

Variables that affect the intercept positively are:

- Community financial contributions for the hiring of additional teachers. This effect is relatively small (13 test points) and most likely indicates affluent and well-functioning historically advantaged schools;
- The proportion of students that speak English at home. There is a large positive effect associated with having a greater proportion of English speaking students; this also most likely indicates some formerly white or Indian schools. Due partly to higher SES and also to a history of relative advantage, these schooling systems outperformed former black schools in terms of school management, efficiency of resource usage, etc during the apartheid era;
- Test frequency. Being in a school where the mathematics teacher gives students at least 2-3 mathematics tests per term raises test scores by approximately 42 points. The fact that higher test frequency is important for test results suggests that regular monitoring is beneficial for learning regardless of school context and quality. Note however that an alternative specification of the model (not shown here) indicates that increasing testing to once or more per week does not seem to bring additional benefits;
- School facilities. Schools with better facilities (described here by an index spanning a range 0-23) appear to offer better quality education. This variable is highly correlated with the SES of students attending a given school, suggesting that it is also to some extent capturing information about historical advantage; if this is true, it may be that it is merely acting as a proxy for other hard-to-measure school quality factors that are positively correlated with former department.

Interestingly, neither the PTR nor classroom resources have statistically significant effects on student performance. In addition, the effects of these two variables are very small. This is the type of result frequently noted in research on the observed tenuous link between resources expended on education and quality of schooling. Further, being in an urban school does not necessarily raise test scores by much, once other factors have been considered; the benefit attached to education in such a school is only marginally significant.

Attention shifts next to trying to understand how individual SES affects student performance through school level factors. An investigation into the channels through which school average SES influences test scores was launched through adding school management and teacher variables as determinants of the student SES slope. Teacher quality is measured by a dummy variable indicating that the mathematics teacher has a degree and another indicating that the teacher has teaching training. In contrast to the lack of a statistically significant relationship that emerges when the two teacher quality variables are added to the intercept (rather than to the SES slope), both come through strongly and positively, with teacher training having a particularly large effect on test scores via SES. This may indicate any of the following:

- That teacher quality only matters in schools with a more affluent student base because (unmeasured) school management is of a sufficient quality to utilize these teacher resources efficiently;
- That schools serving more affluent students and performing better are able to employ teachers with educational qualifications of higher quality;
- That the impact of having a good teacher is largely restricted to children of a higher SES – i.e. those with a family background that supports learning better are likely to reap substantially better benefits from good quality education than those that do not.

This is an unexpectedly interesting finding, given that many previous attempts to measure the impact of teacher quality on student performance in South Africa have been foiled by the uninformative nature of conventional teacher quality measures. This may be one of the greatest benefits of the rich SACMEQII datasets: that it allows analysis in greater detail and thus allows for disentangling different effects. Figure 4 below shows the mean proportion of mathematics teachers with tertiary education and the mean proportion of mathematics teachers with teaching training by school SES quintile. Note that particularly the latter measure is very noisy, in the sense that more than 80 per cent of schools in each quintile contain mathematics teachers with teaching training. However, these qualifications – and indeed all of the tertiary education that teachers possess – are of highly varying type and quality, as the current generation of teachers was also trained in a highly segmented education system. Further information on the quality of teachers' education is not generally easy to come by. However, still further progress is required on the research frontier; for although the analysis in this paper shows that teacher quality matters differently for students at various points on the SES spectrum, it is unable to identify the mechanisms through which teacher quality operates within schools serving students from diverse family backgrounds.

In addition, teacher absenteeism appears to matter more as student SES increases. Given the high correlation between student and school SES, this suggests that teacher absenteeism affects mathematics learning more adversely where teacher quality is high or where school management is sufficient to properly utilise available teacher resources. The empirical evidence tells one that teacher absenteeism determines both the efficiency of schools in producing schooling outcomes (reflected in the intercept) and the channels through which student SES determines test scores (in other words, the equity of the distribution of test scores).

With regard to school management, the variable that emerged as particularly important was a concern with monitoring students' progress held by the school principal (i.e. school head believes monitoring student progress is his/her most important activity). The fact that this variable and the teacher quality measures only emerged as significant predictors of student achievement when modelled as determinants of the SES slope supports the hypothesis that a problem of poor management of school resources – and thus gross inefficiency – prevents poorer, formerly disadvantaged schools from transforming schooling resources into outputs. This may be a larger problem than the inferior availability of resources experienced by these schools; in fact, Van der Berg and Louw (2006) show that South African students are relatively advantaged in terms of resource availability (both at the school level and the household level) in regional context. Finally, a principal reported problem of teacher absenteeism has a large negative coefficient (23 point test score penalty). This suggests that teacher absenteeism has a greater adverse impact on student performance in well-functioning schools, once again probably due to these schools' greater efficiency in the production of schooling outputs.

4. Conclusion

This paper has shown that South African primary schools perform poorly in a regional context, and that this particularly applies to the bulk of schools disadvantaged under the previous political dispensation. Regional comparison shows that weak performance of the schooling system cannot be ascribed to the resource endowment of schools or even to the poverty of the households from which their students are drawn. Consequently, further investigation was required into the reasons for rich schools being so much better at converting SES advantage into student performance.

Using the SACMEQII dataset, this study has gone one step beyond what has hitherto been possible in explaining South African student performance. Quantitative analysis shows that the better mathematics performance of richer schools is clearly associated with a number of identifiable variables, some of which may proxy for school management and functioning. In particular, teacher absenteeism, principal monitoring of student progress, and teacher quality are all factors that

determine performance, and that interact with student socio-economic background in determining performance.

As a result, this paper shows why richer students gain from attending better functioning schools: teacher absenteeism is less common, teachers are better qualified, and principals are more concerned with monitoring student progress. None of this should come as any surprise, but the research findings do have important policy consequences. If these are the factors that characterise good schools, then mechanisms are needed to ensure that these characteristics also become entrenched in weaker performing schools. Whilst attempts at improving teacher qualifications are laudable and important, they may take a long time to bear fruit for most rural or even township schools. However, attention to introducing better accountability measures to reduce teacher absenteeism and to emphasise monitoring of student progress may have large payoffs. This is likely to require greater attention to measurement of student progress at regular intervals over the school career, to allow feedback on performance to students, parents, teachers, principals and education authorities alike.

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Appendix:

Hierarchical linear modelling is used for estimation where nesting occurs at two or three levels. In the case of a means-and-slopes-as-outcomes hierarchical linear model, both the intercept term and the slope coefficients in the level 1 (student-level) equation are modelled through adding regressors to explain these at level 2 (school-level). A particular benefit is that school-specific variation in relationships between education inputs and outputs can be allowed for by adding random effects for each school.

When reading the HLM results in this paper, it is useful to know that the reliability ratio reflects the average reliability of random intercepts and slopes if OLS were used. A high reliability ratio then suggests that the random effects should be retained, while a low reliability ratio (<0.10) indicates that fixed effects are more appropriate than either random effects or non-randomly varying effects. Reliabilities depend on the extent of variation between groups in the true underlying parameters, and on the precision with which each group's regression equation is estimated. The reliability ratio is thus close to 1 when the group means vary substantially across schools, or in large samples (Raudenbusch & Bryk 2002: 46).

One measure of goodness of fit for hierarchical linear models is the proportion of variance in the dependent variable (i.e. test scores, in this case) that they explain. Analogous to the R-squared statistic in OLS regression models, the proportion of variance explained at level 1 describes how well the level-1 equation explains variation within level-2 units (i.e. schools) at level 1 (i.e. the student level). The HLM model (2) explains 7 per cent of the total variation in test scores within schools. This low explanatory power of the level-1 equation is unsurprising given that many of the factors affecting learning at the student level are household-level and individual-level factors that are difficult to quantify. Ability is an important determinant affecting individual performance, although no measure of this variable is available in the data.

When evaluating the part of the model that explains school-level variation, bear in mind that the intraclass correlation coefficient, ρ , describes the proportion of variance in test scores that can be explained by between-school factors. In this model, there are two level-2 equations, the first modelling the level-1 intercept and the second modelling the effect of student SES on test scores. The proportion of variance in the intercept explained by the model is 82 per cent, while the proportion of variance in the level-1 SES slope explained by the model is 29 per cent. The former is high, suggesting that determinants of school performance might not be as difficult to quantify as one might be tempted to think. However, the remaining difficulty is that many of the indicators of good school quality may be reflecting historical advantage rather than providing policymakers with firm

1. Table 1: Mean educational attainment in years of education completed of 16-20 year olds, by race and parent education level							
Data set	Race group	Average Parent Education Category					Total
		0 yr No Schooling	1-6 yrs Incomplete Primary	7-11 yrs Incomplete Secondary	12 yrs Complete Secondary	>= 13 yrs Tertiary Qualifications	
Census 1985	Black	4.94	6.86	8.36	7.84	7.19	6.65
	Coloured	5.49	7.10	8.93	9.09	8.50	7.72
	Indian	9.61	10.07	10.74	11.40	11.57	10.44
	White	9.75	10.16	10.81	11.26	11.43	11.00
	All	5.20	7.16	9.28	10.45	10.55	7.79
Census 2001	Black	7.56	8.86	9.83	10.40	10.81	8.87
	Coloured	7.23	8.74	10.17	10.93	11.43	9.73
	Indian	9.54	10.71	11.32	11.49	11.86	11.30
	White	8.39	10.24	10.72	11.21	11.49	11.13
	All	7.56	8.87	10.04	10.82	11.23	9.23

Table 2: Mean pupil-teacher ratio by country in SACMEQII

Botswana	28.3
Kenya	33.4
Lesotho	53.9
Malawi	70.0
Mauritius	24.5
Mozambique	51.3
Namibia	31.5
Seychelles	16.6
South Africa	36.5
Swaziland	35.1
Tanzania	47.1
Uganda	58.0
Zambia	53.7
Zanzibar	35.0
Total	40.7

Table 3: Hierarchical linear models for South African mathematics test scores, SACMEQII

	Model 1			Model 2			
	Coefficient	Std error	df	Coefficient	Std error	df	
Model for intercept:							
Intercept	γ_{00}	502.9911 ***	33.6113	149	504.3900 ***	33.6560	149
PTR	$\gamma_{01 \#}$	0.6031	0.4742	149	0.6420	0.4730	149
Average student absenteeism	$\gamma_{02 \#}$	-7.2398 ***	1.9169	149	-6.9490 ***	1.9090	149
Classroom resources (range 0-8)	$\gamma_{03 \#}$	0.9333	2.0560	149	0.9510	2.0610	149
School facilities (range 0-23)	$\gamma_{04 \#}$	2.9136 ***	0.8137	149	2.8680 ***	0.8150	149
Proportion students always speak Eng	$\gamma_{05 \#}$	39.9559 **	18.9494	149	40.8590 **	19.1340	149
Proportion students repeat 3 grades	$\gamma_{06 \#}$	-50.3493 *	28.4889	149	-49.3750 *	28.9330	149
Urban (1=yes)	γ_{07}	20.6077 *	12.0719	149	19.8200	12.0470	149
Teacher absenteeism (1=yes)	γ_{08}	-79.6523 ***	12.4239	149	-82.2510 ***	12.5050	149
Extra teachers hired (1=yes)	γ_{09}	13.6174 *	6.9586	149	13.4820 *	6.9910	149
Tests 2-3+ times per term (1=yes)	γ_{10}	42.2101 **	17.6739	149	41.9440 **	17.7180	149
Model for SES slope:							
Intercept	γ_{60}	7.8015 ***	2.2281	158	-0.5710	8.9380	155
School average SES	$\gamma_{61 \#}$	9.0342 **	3.7476	158			
Teacher has degree (1=yes)	γ_{62}				12.5040 ***	4.7400	155
Teacher has teaching training (1=yes)	γ_{63}				22.8390 ***	5.2080	155
Monitoring student progress is most important activity: principal (1=yes)	γ_{64}				10.2920 **	4.2720	155
Teacher absenteeism problem (1=yes)	γ_{65}				-23.1800 ***	6.9680	155
Other fixed effects:							
Repeat once (1=yes)	β_1	-11.9512 ***	2.9776	2953	-12.1000 ***	2.9730	2950
Repeat twice (1=yes)	β_2	-12.9087 ***	4.7950	2953	-13.5390 ***	4.7600	2950
Repeat 3+ times (1=yes)	β_3	-18.8577 ***	4.7396	2953	-18.1320 ***	4.7150	2950
Days absent during month	$\beta_4 \#$	-1.0657 *	0.5900	2953	-1.0770 *	0.5850	2950
Stationery item index (range 0-6)	$\beta_5 \#$	3.5469 ***	0.9520	2953	3.5350 ***	0.9480	2950
Male (1=yes)	β_7	3.4631	2.8110	2953	3.2800	2.7510	2950
Over-age (1=yes)	β_8	-13.4299 ***	2.6320	2953	-13.7170 ***	2.6520	2950
English sometimes (1=yes)	β_9	11.1492 ***	3.9695	2953	11.2120 ***	3.8320	2950
English always (1=yes)	β_{10}	20.1224 ***	5.1436	2953	20.5820 ***	5.0850	2950

Variable is grand-mean centred

*** Significant at 1 per cent level ** Significant at 5 per cent level * Significant at 10 per cent level

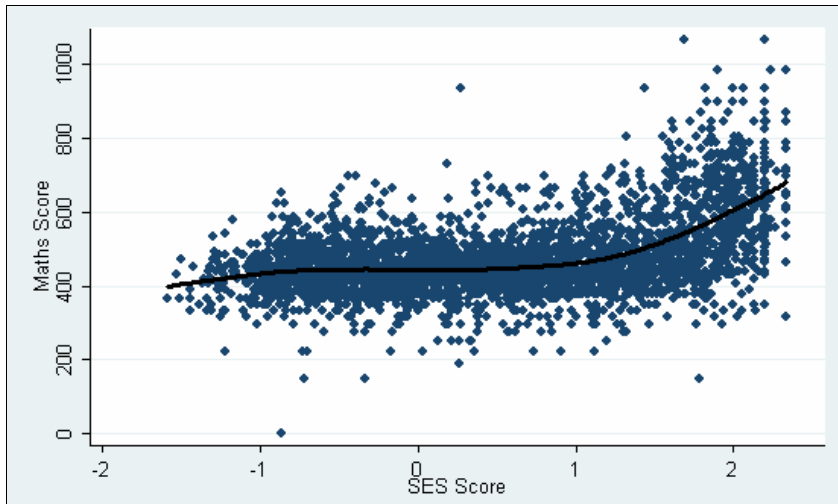
Table 3: Hierarchical linear models for South African mathematics test scores, SACMEQII (cont.)

Stays with parents (1=yes)	β_{11}	10.2865 ***	3.1743	2953	10.3310 ***	3.1110	2950
Books 11 or more (1=yes)	β_{12}	8.8827 ***	3.2656	2953	8.7490 ***	3.3530	2950
Absent fees unpaid (1=yes)	β_{13}	-12.4238 **	5.7050	2953	-13.2130 **	5.6350	2950
Mother tertiary qualification (1=yes)	β_{14}	8.4655 *	4.8470	2953	8.5390 *	4.8420	2950
Eastern Cape (1=yes)	β_{15}	-33.0269 **	16.4902	2953	-32.9740 **	16.6420	2950
Free State (1=yes)	β_{16}	-88.5309 ***	15.7887	2953	-89.2520 ***	15.8210	2950
Gauteng (1=yes)	β_{17}	-38.1340 **	14.8713	2953	-36.9730 **	15.0850	2950
Kwazulu-Natal (1=yes)	β_{18}	-21.1264	18.7837	2953	-21.3260	18.9360	2950
Mpumalanga (1=yes)	β_{19}	-49.6079 ***	14.3261	2953	-49.5930 ***	14.5610	2950
Northern Cape (1=yes)	β_{20}	-61.6738 ***	18.1994	2953	-60.7960 ***	18.2190	2950
Limpopo (1=yes)	β_{21}	-34.9751 ***	16.3985	2953	-35.0730 **	16.5590	2950
North West (1=yes)	β_{22}	-78.8089 ***	18.5487	2953	-78.4300 ***	18.6700	2950
Random effects		Std deviation	Variance	df	Std deviation	Variance	df
Intercept	U_0	35.4231 ***	1254.7971	149	35.4180 ***	1254.4070	149
SES	U_6	10.6821 ***	114.1062	158	10.0020 ***	100.0370	155
Level 1	R	62.5456	3911.9491		62.4220	3896.4940	

Variable is grand-mean centred

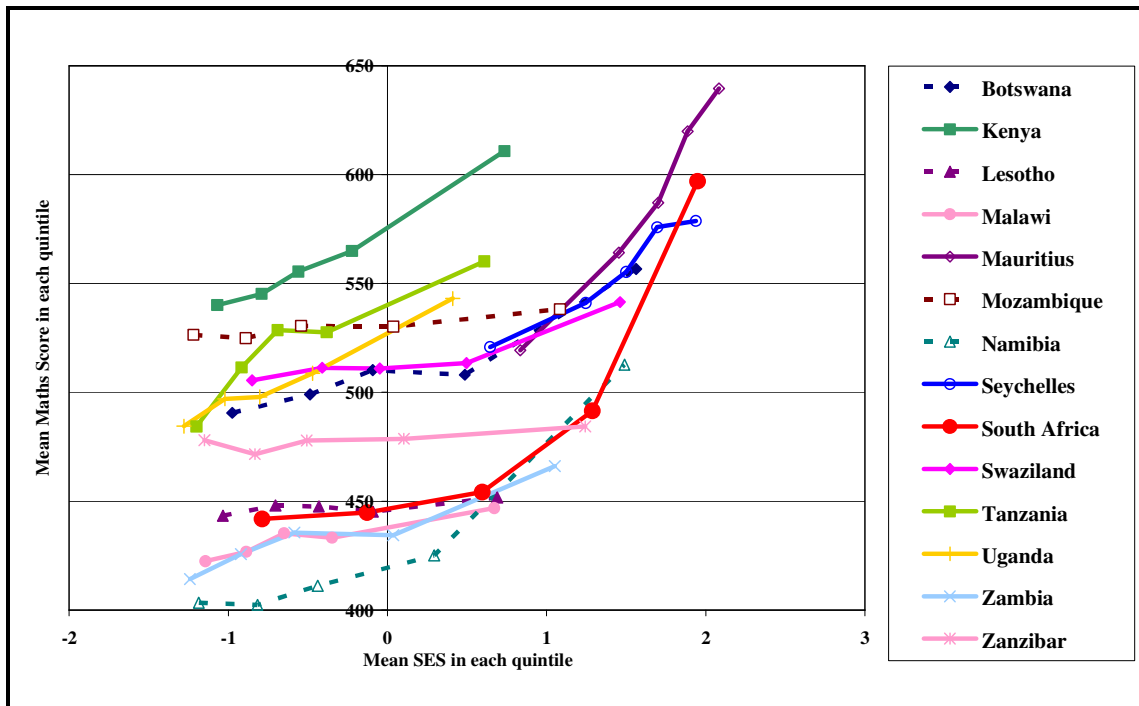
*** Significant at 1 per cent level ** Significant at 5 per cent level * Significant at 10 per cent level

Figure 1: Lowess regression on student mathematics score, South Africa



Source: Analysis on SACMEQII, 2000

Figure 2: Mean SES and mathematics test score by country and quintile



Source: Analysis on SACMEQII, 2000

Figure 3: Proportion of schools reporting a teacher absenteeism problem by school SES

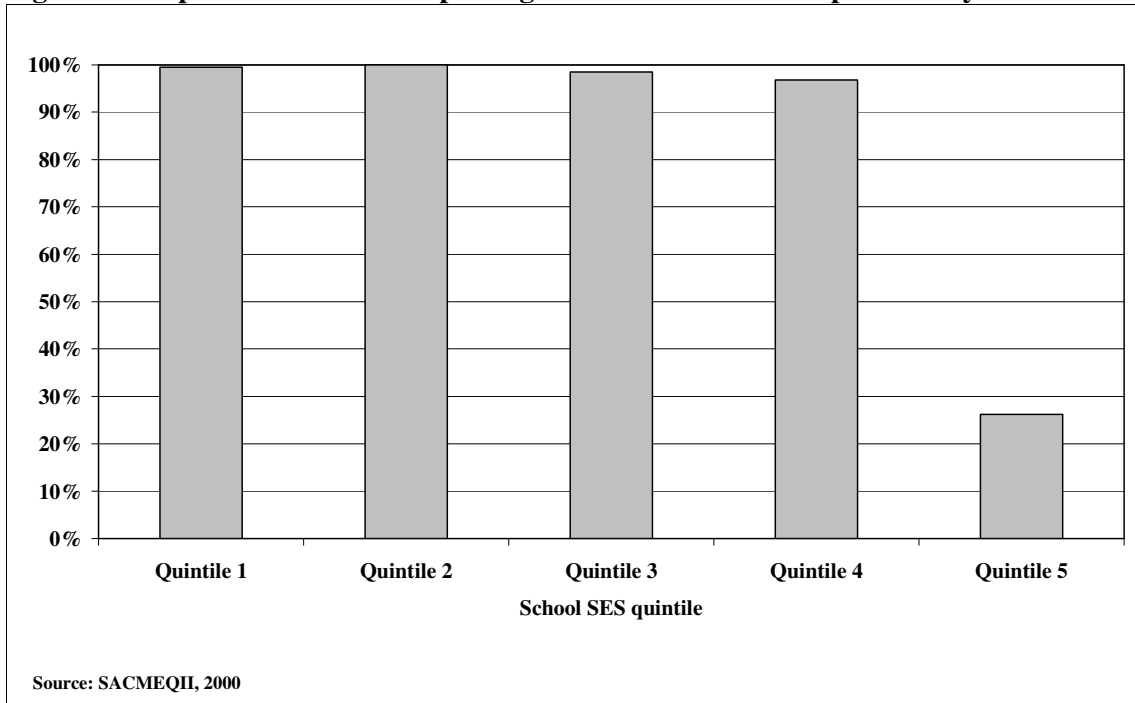


Figure 4: Conventional measures of teacher quality in SA by school SES

