The effectiveness of inputs in primary education: Insights from recent student surveys for Sub-Saharan Africa

Fehrler, S; Michaelowa , K; Wechtler, A

The Effectiveness of Inputs in Primary Education:

Insights from Recent Student Surveys for Sub-Saharan Africa

This is an electronic version of an article published in the Journal of Development Studies, Volume 45, Issue 9, available online at:

http://www.informaworld.com/smpp/pwreset?id=916960109&dt=4013467207843&ck=45D4B817970C96B072AD8BDBB7DD5A10.

Authors

Sebastian Fehrler
University of Zurich / Institute of Political Science; Hirschengraben 56; CH-8001 Zürich; +41 44 6345270
sebastian.fehrler@pw.uzh.ch

Katharina Michaelowa
University of Zurich / Institute of Political Science; Hirschengraben 56; CH-8001 Zürich
and
Hamburgisches Welt Wirtschafts Institut (HWWI)
katja.michaelowa@pw.uzh.ch

Annika Wechtler
Hamburgisches Welt Wirtschafts Institut (HWWI)
a.wechtler@gmx.de

Please contact Sebastian Fehrler for correspondence concerning the article.

Abstract

With SACMEQ and PASEC there are now two large data bases available on student achievement, socio-economic background and school and teacher characteristics in both anglophone and francophone Sub-Saharan Africa.

A joint analysis of PASEC and SACMEQ in a common education production function framework allows us to estimate the impact of educational inputs on student achievement in 21 sub-Saharan African countries and to compare our results with those of earlier empirical studies for education systems in Africa and other world regions.

In our analysis we focus on school equipment, teacher quality and class organisation. The issue of teacher and student incentives cannot be adequately addressed with the given data.

Our results are based on a traditional retrospective analysis of student achievement in PASEC and SACMEQ countries. In contrast to the 'nothing works' result from most industrialized countries' studies we find robust positive correlations of achievement test scores and the possession of textbooks and negative correlations with teaching in shifts. The most striking result is the weak or even absent correlation of achievement test scores and teacher education and professional training. However, some differences between francophone and anglophone education systems can be observed in this context if differences in the sampling methodology are duly taken into account.

Introduction

The increasing availability of student survey data, the development of new statistical and econometric methods and the expansion of computing capacities has led to a huge increase in scientific evaluations of the determinants of education quality in recent years. Education quality is thereby measured in terms of student achievement on standardized tests, which reflects the cognitive knowledge acquired through the education process. In line with international policy priorities as codified in the Education for All (EFA) objectives and the Dakar Framework for Action, for sub-Saharan Africa, evaluation efforts currently concentrate on the primary level. In addition to various national level evaluations, three programs have been launched on a larger scale: Together, the UNESCO/UNICEF Monitoring Learning Achievement (MLA), the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) and the Programme d'Analyse des Systèmes Éducatifs de la CONFEMEN (PASEC) now cover most countries on the continent. General information on these programs is available from Chinapah (1997) for MLA, Ross (1998) and Murimba (2000a,b) for SACMEQ, and PASEC (1999) and CONFEMEN (2008) for PASEC.

SACMEQ and PASEC are of particular interest because they use comparable (or identical) tests in all their countries, which allows us to jointly analyse different country cases as well as to draw comparisons across countries. While the comparison of test items and thus a direct comparison of achievement levels across programs is not yet possible, the relationship between inputs and outcomes can be compared.

A joint analysis of PASEC and SACMEQ data in a common education production function framework allows us to estimate the impact of educational inputs on student achievement in 22 sub-Saharan African countries, and to compare our results with those of earlier empirical studies for education systems in Africa and other world regions. The

aim is to see which inputs work in the production of primary education and might, therefore, be considered for policy interventions.

As SACMEQ data have only recently become publicly available, to our knowledge, this study presents the first attempt to jointly explore results for francophone and anglophone Africa in a common education production function framework.

An education production function defines the structural relation between inputs and achievement (skills learned). In general it can be depicted as (following Glewwe and Kremer 2006):

$$A=a(S,Q,C,H,I)$$

with *A* denoting achievement and *S* years of schooling. *Q* is a vector of school and teacher characteristics, *C* a vector of child characteristics, H a vector of household characteristics (socioeconomic) and *I* a vector of inputs controlled by the parents (such as help with homework).[1]

Experimental and quasi-experimental evaluations are generally better suited to identify causal relationships but we still believe in the value of showing correlation patterns for a huge dataset with a much wider coverage than randomised experiments such as those run by the MIT. Robust correlations can then be cross-checked using other methods than retrospective regression analysis.

The impact of traditional school resources on student learning

There is a considerable number of studies on the impact of traditional school resources on student learning including excellent literature reviews such as UNESCO (2004), Hanushek (2003), Glewwe and Kremer (2006). As outlined in most of the literature reviews, generally, the results of different empirical studies are highly inconsistent, and the overall picture is rather bleak in terms of truly promising policy

options. In fact, many of the studies raise doubts about the relevance of traditional inputs in the schooling production function altogether (Hanushek 2003, Glewwe and Kremer 2006, Glewwe, Kremer, Moulin and Zitzewitz 2004). Although there have been large improvements in the levels of school resources around the world, no corresponding improvement of student learning could be observed. As Hanushek puts it:

'Class sizes have fallen, qualifications of teachers have risen, and expenditures have increased. Unfortunately, little evidence exists to suggest that any significant changes in student outcomes have accompanied this growth in resources devoted to schools.' (Hanushek, 2003: F67)

This is especially true for countries in which the level of school resources is already high. However, one should expect the relationship between resources and outcomes to be much clearer for developing countries as the low initial level of resources makes it more likely that additional inputs have a significant effect. Indeed, looking at 96 production function estimates in less developed countries reveals a somewhat stronger support for the expected positive relationship between inputs and achievement (Hanushek, 2003: F84). Analysing 60 studies of education in developing countries, Fuller (1987) also finds that resources were more important determinants of students' achievement in developing countries than in industrialized countries. Fuller and Clarke (1994) reinforce this conclusion taking into account the cross-country differences in socio-economic and cultural settings even within developing countries.

We conclude that despite rather discouraging evidence on the international level, for developing countries in general, and for most of the very poor sub-Saharan African countries in particular, school resources still play an important role in improving education quality. However, even for these countries, the estimated relationship between

school resources and student achievement is far from consistent across studies, so that there is no easy recipe for successful policy interventions.

Data and econometric methods

In our paper we will examine the evidence from PASEC and SACMEQ data, using a common education production function framework, to assess whether the results from the literature are consistent with results from this unique dataset covering a large part of sub-Saharan Africa. To start with, let us discuss the data coverage and sampling methods as well as our econometric approach.

Data

The SACMEQ data base includes more than 40 000 sixth grade students from 13 countries: Botswana, Kenya, Lesotho, Malawi, Mauritius, Mozambique, Namibia, Seychelles, South Africa, Swaziland, Tanzania (main land and Zanzibar are treated like two distinct countries), Uganda and Zambia. The PASEC data used here includes more than 17 000 fifth grade students and the same number of second grade students from eight countries: Burkina Faso, Cameroon, Côte d'Ivoire, Madagascar, Mali, Niger, Senegal and Togo. All surveys were carried out between 1995/1996 and 2001/2002. For both sets of countries, we estimate the effect of various policy options on student test scores in literacy and mathematics. The policy options discussed include the provision of better learning materials (for example textbooks, teacher manuals), teacher qualification and the organisation of student flows. All effects are calculated after controlling for the influence of student socio-economic background, for example possessions at home, mothers' and fathers' education, language spoken at home and so forth.

Some conceptional differences in PASEC and SACMEQ evaluation methodology and survey design may have a non-negligible impact on estimates of regression coefficients and standard errors, as well as on their interpretation.

Only SACMEQ includes student weights, which can be used in the regression in order to ensure that the overall results are truly representative. Most PASEC surveys are designed to be representative surveys of schools, but it is not taken into account that the probability of any particular student to be part of the sample also depends on the size of the school. For Togo, Mali and Niger, they are not representative for schools, either, because they were designed to study specific policy measures (that is contract teachers and double shift teaching). This may result in some selection bias, and there are no weights to adjust for the non-random selection ex-post.

A more obvious difference between PASEC and SACMEQ is their focus on different grades. Clearly, differences must be expected between students' learning in the early grades (like PASEC second grade) and later grades. However, the differences between PASEC fifth grade and SACMEQ sixth grade appear to be less substantial. While drop-out increases from year to year, overall completion rates are higher in SACMEQ than in PASEC countries, so that the effect of sampling students from a one-year higher grade which may counter the effect of sampling students. Another concern could be that in many countries, sixth grade is the last year of primary education, which may make it an atypical year, difficult to compare with other years. However, it turns out that in most SACMEQ countries, primary schooling includes one more year and ends only after 7th grade. Thus in this respect, there does not seem to be a major problem for comparisons between PASEC and SACMEQ.[2]

Regression methodology

For both sets of countries, the dependent variable used in our regressions is the test score in literacy and mathematics. This test score is coded on a scale with mean 500 and standard deviation 100 for SACMEQ. For PASEC it is the simple percentage of correct answers (0-100 per cent). The distribution of this variable is characterized by the following means and standard deviations:

- 5^{th} grade French: mean 41.7 per cent, standard deviation 18.2 per cent
- 5^{th} grade Maths: mean 43.9 per cent, standard deviation 18.2 per cent
- 2^{nd} grade French: mean 52.2 per cent, standard deviation 25.3 per cent
- 2^{nd} grade Maths: mean 50.5 per cent, standard deviation 24.3 per cent.

The distribution of the scores across the countries is presented in the Appendix (Figure 1). All countries within each country group (SACMEQ/ PASEC) are considered jointly in a single regression. This has the considerable advantage that, due to the high total number of observations, even very small effects can be distinguished. Country differences are captured by country fixed effects.

We use two different econometric models to estimate the education production functions. For both SACMEQ and PASEC, model type A is the usual hierarchical linear (or multi-level) model with school random effects (for textbook expositions see for example Raudenbush and Bryk, 2002 or Goldstein, 2003). Estimations are carried out with generalized least squares (GLS) with the exception of SACMEQ regressions because the availability of sampling weights makes maximum likelihood estimation (MLE) computationally more attractive in the multi-level framework.

Model A has the advantage of providing a clear distinction between the explanations of the variance within and between schools. However, the true standard errors may be underestimated if sub-clusters exist (such as classes within schools for SACMEQ or groups of students living in the same area or doing their homework together), which lead to a variance structure different from the one explicitly specified. As a robustness check, we therefore introduce a model type B using the Stata survey sampling routine. For details, see Michaelowa and Wechtler (2006). For a comparison of the different methodologies and their results, see Brown and Micklewright (2004).

More robustness checks

In PASEC students were tested twice, once at the beginning and once at the end of the year. Before including a pre-test score in a regression function one should consider the following. First, it is a relevant control variable for general ability and the influence of student background which might not have been fully captured otherwise. Its inclusion can avoid (or reduce) omitted variable bias when estimating the effects of relevant policy measures. Second, it changes the interpretation of all coefficients as the control for the score at the beginning of the term implies that the coefficients of all other variables reflect the influence on students' progress over the year, rather than on students' final skills. This is why econometric models including a pre-test score are also known as "added value models" (Hanushek, 1986). And third, many teacher and classroom related variables change over the years, so that a precise estimation of their impact is only possible for the ongoing term. For example, the student may have got a high performing teacher for the current term, but had bad teachers before. Now since the overall skills of this student are influenced by all these teachers, the positive influence of the last teacher will be blurred in any model in which initial student skills (before they got this teacher) cannot be taken into account. As we want to compare results between

SACMEQ and PASEC countries and pre-tests are only available for PASEC, the regressions including pre-tests serve as robustness checks of the correlation found in the other regressions.

Alan Krueger (1999) demonstrates that such added value models do not solve all problems. In his study on the effect of changes of class size, he shows that there exists a rather big initial level effect at the first grade and afterwards only small effects of small class sizes. The level effect can not be observed in a value added model. We find it very unlikely, though, that most inputs work only in grade one and afterwards differences in inputs play a much smaller role. Therefore, we believe that this shortcoming is not too important and that an added value specification is a valuable robustness check.

To check for selection bias due to the unrepresentative sampling in Mali, Niger and Togo we estimated all PASEC regressions without those countries but found almost exactly the same results.

To check for the effect of private schools which might have different production functions we ran the SACMEQ regressions without private schools. Again the results were almost unaffected by the exclusion. For PASEC the school type is not recorded for some countries and not consistently for others. Therefore, we could not exclude private schools here to check for robustness.

As some regressors such as double shift teaching, parental help with homework and inspector visits to the school are arguably endogenous we also ran regressions without these three variables and found again no substantial changes in the other coefficient estimates.[3]

In addition to these robustness checks we looked at all relevant coefficients discussed in the next section in single country regressions for all countries. The results are reported in the Appendix (Tables 7 and 8).

Econometric evidence for francophone and anglophone Africa (PASEC and SACMEQ)

The Appendix includes two detailed tables with regression results for literacy and mathematics respectively (Tables 5 and 6). The following discussion concentrates on the most relevant results (Tables 1-4). Most results are in line with the findings for developing countries in general and are also discussed in Michaelowa and Wechtler (2006).

Traditional policy options

Textbooks, wall charts, other equipment

We find significant effects of textbook possession for maths in all grades and for French in second grade in the PASEC sample. The magnitude of the estimated effects ranges from 3.4 per cent of a standard deviation to 14.1 per cent. The higher coefficient for textbooks in French in second grade can mean that it is more important to personally possess a book in lower grades. One could imagine that in lower grades, being able to take the book back home for first reading practice is more relevant than in higher grades. However, high coefficient estimates and significant results for individual textbook possession may also be an artefact of the lack of two relevant control variables - parents' literacy and books at home - which were not included in the questionnaire for second grade students. As the expected correlation between these variables and textbook availability is positive, second grade coefficients for textbooks are likely to be biased

upwards. Moreover, the generally lower level of initial textbook availability in earlier grades may lead to higher coefficients if there are diminishing returns to overall textbook coverage (for a more general discussion of such nonlinearities see Frölich and Michaelowa, 2005). Thus the distinction between grade levels is more complex here than it might seem at first glance.

Textbooks are also considered for spill-over effects included in the effect of the share of pupils with a textbook in the class. The coefficient for the variable which indicates with how many classmates a student has to share a textbook in the SACMEQ sample is significant and positive at the 5 per cent level. The insignificant coefficients for the share of classmates with textbook in the PASEC sample are rather surprising taking into account the strong peer-effects estimated in an earlier non-parametric study on a smaller sample from Burkina Faso, Cameroon, Senegal, Ivory Coast and Madagascar (Frölich and Michaelowa, 2005). Interaction of class share and personal possession might be a reason for these results as both variables are included, although the specification chosen seems to be a good approximation of the functional form found in the Frölich and Michaelowa study. Nevertheless the importance of availability of books is clearly shown.

A question about wall charts was asked only in SACMEQ countries. The coefficient estimate is positive, as expected, but remains insignificant. Teacher manuals are significant in some regressions (only for SACMEQ) and then lead to a positive effect of up to 6.7 per cent of a standard deviation in test scores. For PASEC, they become significant in different regression specifications with a lower number of general equipment variables and for a different set of countries (not shown here). But results are clearly less robust than for textbooks.

All in all, these results appear to be consistent with earlier studies for developing countries, which show a somewhat positive, but moderate impact of learning materials, especially textbooks (for a review, see for example Mingat, 2003). We spent much time trying to find appropriate indicators using different combinations of classroom furnishings, school facilities and basic equipment, such as chalk and blackboards. The final specification presented in Tables 5 and 6 includes a variety of separate indicators for individual items and facilities, a joint indicator for higher technology equipment, such as computers, television and video projectors, an indicator for the availability of electricity and an indicator for the general condition of the school building.

At first glance, looking at SACMEQ regressions, our results seem to present a strong evidence for the relevance of expensive electric equipment. The indicator for higher technical equipment is strongly significant and indicates that adding any high tech item to the existing equipment of a school raises student achievement by more than 12 per cent of a standard deviation. However, this variable must be considered with caution, as it may well suffer from an endogeneity problem: As high tech equipment is an easily visible signal of a rich school environment, wealthy parents and parents with particularly talented children may select these schools in the first place. As most parents can be expected to make their school choice only once (that is at the beginning of primary education), controlling for the initial score at the beginning of the year, as possible with PASEC data, will eliminate at least part of this selection effect. Unfortunately, the high tech indicator is not available in PASEC, but electricity, a strongly correlated variable, is. In PASEC, the effect of electricity is significant at the 10 per cent level at second grade in French, but only as long as the pre-test score is not included into the regression. Controlling for the pre-test scores leads to a jump of all p-values from below 0.2 to over 0.7.

In SACMEQ, the availability of a school or classroom library also appears to be significant, whereby the existence of the library in the classroom itself seems to be more directly beneficial. Not surprisingly, results for reading are higher than for maths and make up 3.9-9.7 per cent of a standard deviation in literacy scores. The library result is also reflected in two of the PASEC regressions (grade 2). One might take this as yet another indication of the relevance of books in the learning process. Note that libraries also offer a compensation for a scarcity of reading material at home. The variable "books at home", which is introduced as one of the control variables for students' family background, is strongly significant in all literacy and two of four mathematics regressions. This reinforces the potential relevance of libraries in general, be it at classroom or school level, in the village or town, or in the more flexible form of a "rolling library", which appears to be a good solution for scarcely populated rural areas.

Nevertheless, it should be noted that coefficients for school libraries shrink considerably and become insignificant when the pre-test scores are controlled for. This suggests that, just as in the case of technical equipment, a self-selection process of good performers into well-equipped schools may bias the results.

A similar argument applies to the interpretation of the coefficient for the condition of school buildings. The condition of school buildings - only included in the SACMEQ analysis - reveals a strong and statistically significant positive effect: A change from extremely bad to extremely good conditions leads to an increase of 1.7-2.4 per cent of a standard deviation of student achievement. However, just as technical equipment and school libraries, the condition of the school building is one of the easily observable characteristics parents may base their school choice on. As the variable is not included in the PASEC analysis, it could not be tested whether the coefficient estimates remain significant when initial knowledge is controlled for. When related variables providing

information about the material the classroom is built with are included in individual PASEC country studies, results generally do not show any relevant positive role of concrete relative to other materials (see for example PASEC, 2009).

Otherwise, very few significant effects can be reported. A certain positive effect of the availability of blackboard and chalk can be observed for mathematics in one SACMEQ regression. For PASEC, the estimates are insignificant. Toilets, health equipment and fresh water do not show a significant positive effect, either. All in all, evidence for relevant effects of school equipment is rather weak, especially when considering potential selection bias and the more reliable estimates controlling for pre-test scores.

Table 1

Table 2

Class size, student-flow, teacher qualification, knowledge and in-service training

Results with respect to class size show the typical insignificant or very small impact on student achievement (for a literature review and discussion of studies on class size see for example Hanushek, 1998). In order to take into account possible threshold effects or other non-linearities, the variable is entered into the regression in a quadratic form. In the case of SACMEQ, where the coefficients are significant, the analysis indicates that negative effects start to become evident beyond a class size of 60 students. This result corresponds to earlier results for PASEC in a regression specification for five countries (Michaelowa, 2001). In the regressions specified here, class size is insignificant for the PASEC countries. Another study based on PASEC

panel data for students in Senegal, controlling for student fixed effects, does not find any negatively significant effect either (Fehrler, 2008).

Teacher qualification is a different issue. For PASEC, neither the indicator of teachers' educational attainment (academic qualification), nor the indicator for professional training is significant at the 5 per cent level. In SACMEQ, however, the academic qualification is clearly significant and the professional qualification is significant in all but one regression. Coefficients for academic qualification indicate that the students gain between 1.8 and 4.1 per cent of a standard deviation in scores when the teacher has attained a one step higher level of education, for example lower secondary attainment instead of primary attainment only, or some tertiary instead of upper secondary only.

It is interesting to note the differences between SACMEQ and PASEC countries here. Although the indicator used is almost identical in both surveys, in PASEC, it is much more difficult to find the expected positive results. The problem appears to be that the indicators of both professional training and educational attainment only capture duration while no information is available on quality. Obviously, depending on quality and practical relevance, two different courses of the same duration may have a totally different impact on actual teaching skills. It can be shown that in PASEC, there is no significant positive correlation between the duration of teachers' educational attainment and teachers' knowledge of the subject matter. This implies that the low coefficient estimates for attainment should not be interpreted as an indication of a low impact of increased subject matter knowledge, but rather as an indication of the low quality of the education the teachers themselves received when they attended school (Michaelowa, 2003).

To measure actual teacher knowledge, PASEC uses an exercise for teachers in which they have to count the mistakes in a fictitious student dictation. In SACMEQ, a different and exceptionally precise indicator of relevant teacher knowledge is available: Teachers were themselves asked to take the students' tests and marked on the same scale. The average teacher score in literacy is more than two standard deviations above average student scores and is reached only by about 2 per cent of the students.

As opposed to PASEC, it can be shown that for SACMEQ countries the correlation between educational attainment and teacher test scores is significant, albeit even here, less pronounced than one might have expected. Estimated correlation coefficients are 0.21 for literacy, and 0.32 for maths. Since we can find a significant correlation only for SACMEQ countries, this may indicate that, on average, the quality of secondary and tertiary educational institutions attended by (future) teachers is better in anglophone than in francophone Africa, at least in the core subjects of literacy and mathematics. This could explain the differing results on the relevance of the academic qualifications. One should be cautious, however, when interpreting these results, because the indicator of teachers' subject matter knowledge in PASEC is much less reliable than the one used in SACMEQ. Moreover, neither in PASEC, nor in SACMEQ are the indicators for teachers' subject matter knowledge available for all countries. This is also the reason why these indicators have not been included directly in our regressions in Tables 5 and 6.

In any case, it should be noted that the coefficient estimates of 1.8-4.1 per cent of a standard deviation for a full level of education (like the whole upper secondary cycle) are not very high. While the linear specification of educational duration used here does not indicate any optimal cut off point, some prior research on PASEC indicates that this

may be below the A-levels or baccalauréat (successful upper secondary completion) (Bernard, Tiyab and Vianou, 2004).

It has been shown that teachers holding a baccalauréat are often less motivated than their peers with lower educational attainment, possibly because their higher expectations with regard to their future jobs are not met by the reality of their situation (Michaelowa and Wittmann, 2007).[4]

As mentioned above, the differences in the significance (or lack of significance) of SACMEQ and PASEC can be observed not only for teachers' academic qualification, but also - in a similar way - for their professional training. In this context, there is no way to directly show from the data that this may be related to a different quality of the courses offered. The correlation between teachers' professional training and subject matter knowledge is not very strong, even in SACMEQ countries, but this is plausible even for very good training modules since professional training could focus on pedagogical rather than academic skills. Most probably, the reason for difficulties in finding significant results in overall PASEC regressions is that professional qualifications vary widely across countries (even within the francophone education systems) and are more or less effective, so that it is very difficult to capture their overall effect.

Individual country estimates for PASEC have often shown the relevance of professional training for student achievement (see, in particular, PASEC, 2004) and we also find a few significant coefficients in our single country checks (see Tables 7 and 8 in the Appendix). In their individual country regressions for SACMEQ, Lee, Zuzu and Ross (2005) construct a joint estimate for academic and professional qualification, so that results are not directly comparable. Nevertheless, they also find that the effect varies widely between countries. A positively significant impact is only found for about one third of the countries covered (and insignificant effects otherwise). In this context, it may be

argued that duration (the only available measure for professional training) is less relevant than content (Michaelowa, 2003; Bourdon, Frölich and Michaelowa, 2006). If the latter could be adequately measured, we would probably face much less variation of results between individual countries and between country groups.

Similar reasoning applies to in-service training (see for example Nguyen, Wu and Gillis, 2005: 40). The latter is negatively significant in SACMEQ. This is a counter-intuitive result also found for individual country cases in francophone Africa, and often related to training sessions during class hours which then reduce effective teaching time (Bernard and Michaelowa, 2006). It should also be noted, however, that in SACMEQ, the in-service training variable is based only on teachers' own subjective assessment of the efficacy of these courses. In PASEC regressions, the variable reflects the number of courses attended per year, and teacher absence can be directly controlled for (in SACMEQ, only an indirect school level variable is available). In this setting, in-service training has a positive coefficient, which is significant for fifth grade French and implies an improvement of up to 6.6 per cent of a standard deviation in students' scores for each additional training seminar the teacher has attended per year (during the last five years).

Student flow organization

Coming to the organization of student flows, our analysis confirms the negative effect of double shift teaching known from other studies (for example Michaelowa, 2001). As the control for pre-test scores generally reduces the overall effect (and makes it statistically insignificant in some regressions), parts of the effect seem to be related to a selection of bad performers in double-shift classes. However, after controlling for initial knowledge, the negative coefficients remain and still indicate losses of often more than 10 per cent of a standard deviation in student test scores for double-shift classes. As

opposed to earlier analysis, we do not find any evidence that this effect is substantially weaker in second grade.

SACMEQ regressions for sixth grade only indicate losses of up to 5.8 per cent of a standard deviation in the case of double-shift organization, and the results are significant only in one regression (even at the 10 per cent level). However, if we look again at the individual country regressions carried out by Lee, Zuzu and Ross (2005), we find that in some countries, this variable does not seem to be relevant in current education practice. In fact, the authors include it only in 9 out of 14 regressions, 4 of which show the expected significant negative effect, sometimes with extremely high coefficients corresponding to up to about 30 per cent of a standard deviation of (international) student scores (Kenya and Zambia). In our single country regressions the coefficient is significant in about one third of the SACMEQ countries (see Appendix).

As opposed to double-shifts, no significant effect in either direction can be discerned for multi-grade teaching. Unfortunately, this variable does not exist in the SACMEQ database. The reason might be that in SACMEQ, very small schools for which this system is generally most relevant have been excluded from the target population.

Table 3

Table 4

Institutions and incentive structures

While the traditional discussion of school inputs focuses on physical goods such as teachers, books, buildings, desks and benches, the "second generation" educational production function literature focuses on more subtle inputs such as accountability, effort and motivation. The idea is that much of the unexplained variation in student achievement may be brought about by differences in these inputs that have previously

been largely neglected by the economic literature. Obviously, their relevance has been widely discussed by educational scientists, sociologists and psychologists, but only in recent years these discussions started to influence the input effectiveness literature.

These institutional features are difficult to analyse empirically along with the physical inputs of the education production function by retrospective regressions. It is often difficult to find appropriate indicators, many of these indicators do not belong to the standard set of variables covered by student surveys, and the concrete forms of implementation vary so much between countries that very detailed information is required to make valid comparisons. Moreover, many indicators such as number of visits by school inspector are very likely endogenous. Therefore, we do not enter the discussion here. However, robustness checks with and without some of these variables (as far as at least some information is available) make us confident that their introduction or omission does not substantially alter the results presented here.

Conclusions

Based on our analysis of student achievement data from 13 SACMEQ countries and eight PASEC countries, we derive several conclusions about the efficacy of a number of inputs in schooling. With the methodology used, causality is not always identifiable. However, our findings and results from other studies point into the following direction.

Pedagogical resources, especially textbooks for the core subjects of reading and maths, can still be considered as effective inputs. If it is not feasible to provide books for all students, one book may be provided only to every second student, especially in higher grades where taking the book back home does not seem to be as important as for very young students.

With respect to teacher education and training, the focus should be on quality rather than duration. In anglophone Africa, where the duration of formal education and teachers' subject matter knowledge are much clearlier correlated than in francophone Africa, longer education for teachers significantly enhances student learning. However, the effect is quite small. Similar results are found for pre-service and in-service training.

Finally, it appears relevant to ensure the maximum use of formal instruction time for effective teaching. Double shift teaching seems to have a detrimental impact in this respect. As there is ample evidence for a rather modest negative impact of high student teacher ratios, double shift teaching should generally be avoided.

Effective teaching time can also be increased by improving students' attendance. Apart from the well-known requirement of adjusting the academic year to harvesting seasons, attendance can be increase by simple health care measures. In this context, de-worming has been shown to be particularly effective (see for example Kremer and Miguel, 2001). And last but not least, effective teaching time can be increased by reducing teachers' absences. In some cases, simple administrative measures like the reorganization of teacher remuneration (so that teachers do not need to collect their pay from a far away district officer) may be very effective. In general, however, more effective control mechanisms seem to be required.

Another relevant issue, not addressed in this study but in many others, appears to be repetition. Repetition increases the overall number of students the system has to deal with and, therefore, reduces the amount of other inputs, like textbooks for example, per student. Moreover, repetition increases early drop-out. Finally, the effects of repetition on student learning have consistently been shown to be negative, rather than positive, at least in the long run. [5]

More research is needed to understand the role of teacher education and training for school quality in Africa. There seems to be much room for improvement in this area, especially when focussing on the content and quality of the training programmes. Moreover, research on teacher and student incentives might help to derive more insights for policy makers. Nevertheless, traditional inputs like school books still appear to be promising options to improve school quality.

Appendix

A1 Distribution of student outcomes across countries

Figure 1

A2 Regression results

Table 5 displays the results for literacy and table 6 presents the results for mathematics. Each of the two tables includes ten regressions, two for SACMEQ (sixth grade only, model A and B), four for PASEC fifth grade (model A and B, with and without pre-test) and four for PASEC second grade. Bold coefficients are significant at the 5% level.

Table 5

Table 6

A3 Single country regressions

The following two tables show single country regression results for all PASEC and SACMEQ countries. The number of regressions in which a coefficient is significant at 5, 10 or 20 per cent is reported for PASEC 5th grade with and without pretest and for SACMEQ 6th grade regressions. The total number of single country regressions is eight in PASEC and 14 in SACMEQ because Tanzania and Zanzibar are treated like separate countries.

Table 7

Table 8

A4 Differences in sampling in SACMEQ and PASEC countries

A relevant issue for our current analysis is that PASEC is sampling students within a single class for each school while SACMEQ is randomly drawing students from the overall sixth grade population within each school in the sample. This implies that for a given number of students drawn in each school and grade (typically 20 students in both surveys), in SACMEQ, we have more variation between teacher and classroom environments, but with only few students to whom this information can be directly related. Conversely, in PASEC we have information on the students actually taught by the same teacher in exactly the same environment. These differences lead to different degrees of precision for our econometric estimates at the different levels (schools, teachers/ classrooms, and students).

In SACMEQ regressions, schools are the only level explicitly considered in the hierarchical models, and the primary sampling units in the survey regressions. In PASEC, the hierarchical level and the primary sampling unit considered is the classroom. The overall impact is difficult to predict. In any case, for SACMEQ, simple two-level hierarchical estimation models which do not take into account any sub-group clustering within schools appear to be problematic. This is the reason for the introduction of an alternative specification using Stata's survey sampling procedures as a robustness check.

Finally, neither in SACMEQ nor in PASEC all schools are included in the defined target population. In PASEC, sampling relies on school mappings available at the ministries of education, which, in some countries, exclude private schools. In SACMEQ, small schools with less than 15 or 20 students, schools for students with special needs and, in some cases, "inaccessible" schools were removed from the initial target population. While in SACMEQ countries, these exclusions never went beyond 5 per

cent, their exclusion may still have an impact on the estimated role of certain variables such as class size, teachers' absence and so forth.

For further details on sample design procedures for SACMEQ, see SACMEQ (2004: section F). For PASEC, a similar brochure is in process and should be available in 2009.

Sample Sizes

Finally, without being related to different sampling procedures, one more difference between our data for SACMEQ and PASEC should be kept in mind when interpreting regression results: Overall sample size is quite different for the two country groups. In SACMEQ, 13 countries are covered while only 8 countries are covered by PASEC (other country data are available since recently, but could not yet be integrated here). In terms of observations for individual students, this leads to a total sample size for SACMEQ which is more than twice as high as in PASEC. Obviously, this influences the precision of coefficient estimates in our regressions.

References

Bernard, J.-M. and Michaelowa, K. (2006) Managing the impact of PASEC projects in francophone Sub-Saharan Africa, in: K. Ross and I. Jürgens Genevois (eds) *Cross-national studies of the quality of education: Planning their design and managing their impact*, (Paris: UNESCO, International Institute for Educational Planning), pp. 229-240.

Bernard, J.-M., Simon, O. and Vianou, K. (2005) Le redoublement: mirage de l'école africaine?, (Dakar: PASEC/CONFEMEN).

Bernard, J.-M., Tiyab, B.K. and Vianou, K. (2004) Profils enseignants et qualité de l'éducation primaire en afrique subsaharienne francophone: Bilan et perspectives de dix années de recherche du pasec, (Dakar: PASEC/CONFEMEN).

Bourdon, J., Frölich, M. and Michaelowa, K. (2006) Broadening access to primary education: Contract teacher programs and their impact on education outcomes in africa-an econometric evaluation for the republic of Niger, in: L. Menkhoff (ed.), *Pro-Poor Growth: Issues, Policies, and Evidence*, (Berlin: Duncker & Humblot), pp. 117-149.

Brown, G. and Micklewright, J. (2004) *Using International Surveys of Achievement and Literacy: A View from the Outside*. (Montreal: UNESCO Institute for Statistics).

Chinapah, V. (1997) *Monitoring learning achievement, follow up to Jomptien*, (Paris: UNESCO/ UNICEF).

CONFEMEN (2008) Son programme d'analyse: PASEC, downloaded on 2/4/08 at http://www.confemen.org/spip.php?rubrique3

Fehrler, S. (2008) *Schule in Afrika*, (Saarbrücken: VDM)

Frölich, M. and Michaelowa, K. (2005) Peer effects and textbooks in primary education: evidence from francophone sub-saharan Africa, HWWA Discussion paper 311.

Fuller, B. (1987) What school factors raise achievement in the third world?.*Review of Educational Research* 57(3), pp. 255-292.

Fuller, B. and Clarke, P. (1994) Raising school effects while ignoring culture? local conditions and the influence of classroom tools, rules, and pedagogy. *Review of Educational Rese*arch 64(1), pp. 119-157.

Glewwe, P. and Kremer, M. (2006) Schools, teachers, and education outcomes in developing countries, in: E. Hanushek and F. Welch (eds) *Handbook of the Economics of Education Vol. 2,* (North Holland: Elsevier), Chapter 14.

Glewwe, P., Kremer, M., Moulin, S. and Zitzewitz, E. (2004) Retrospective vs. prospective analysis of flip charts in Kenya. *Journal of Development Economics* 74(1), pp. 251-268.

Goldstein, H. (2003) *Multilevel Statistical models, 3rd edition*, London: E. Arnold.

Hanushek, E. (1986) The economics of schooling: Production and efficiency in public schools. *Journal of economic literature* 24(3), pp. 1141-1177.

Hanushek, E. (1998) The evidence on class size, *W. Allen Institute of political economy occasional Paper* 98 (1).

Hanushek, E. (2003) The failure of input-based schooling policies. *The Economic Journal* 113(485), F64-F98.

Kremer, M. and Miguel, E. (2001) Worms: Education and health externalities in Kenya, *Poverty action lab paper* 6, pp. 1-64.

Krueger, A. (1999) Experimental estimates of education production functions. *The Quarterly Journal of Economics* 114(2), pp. 497-532.

Lee, V., Zuzu, T. and Ross, K. (2005) School effectiveness in 14 sub-Saharan African countries: Links with sixth graders' reading achievement. *Studies in Educational Evaluation* 31(2-3), pp. 207-246.

Michaelowa, K. (2001) Primary education quality in francophone sub-Saharan Africa: Determinants of learning achievement and efficiency considerations. *World Development* 29(10), pp. 1699-1716.

Michaelowa, K. (2003) Determinants of Primary Education Quality: What Can We Learn From PASEC for Francophone Sub-Saharan Africa*, Background Paper prepared for the ADEA Biennial Meeting 2003,* (Paris: ADEA).

Michaelowa, K. and Wechtler, A. (2006) The Cost-Effectiveness of Inputs in Primary Education: Insights from the Literature and Recent Student Surveys for Sub-Saharan Africa, (Paris: ADEA).

Michaelowa, K. and Wittmann, E. (2007) Teacher job satisfaction, student achievement and the cost of primary education. Evidence from francophone sub-Saharan Africa. *Journal of Developing Areas* 41(1), pp. 51-78.

Mingat, A. (2003) Analytical and factual elements for a quality policy for primary education in sub-Saharan Africa in the context of education for all, *Background paper prepared for the ADEA biennial meeting* 2003, (Paris: ADEA).

Ministère de l'économie et des finances de Burkina Faso (1999) Barème de solde au 1er janvier 1999, Secretariat General, Direction Generale du Budget, Direction de la solde et de l'ordonnancement.

Murimba, S. (2005a) The southern and eastern Africa consortium for monitoring educational quality (SACMEQ). *Prospects* 35(1), pp. 91-108.

Murimba, S. (2005b) The southern and eastern Africa consortium for monitoring educational quality (SACMEQ): mission, approach and prospects.*Prospects* 35(1), pp. 75-89.

Nguyen, K., Wu, M. and Gillis, S. (2005) Factors influencing pupil achievement in sacmeq2-botswana: An application of structural equation modelling, *Paper presented at the International invitational education policy research conference*, Paris: IIEP/ UNESCO.

PASEC (1999) Les facteurs de l'efficacité dans l'enseignement primaire: Les résultats du programme pasec sur neuf pays d'afrique et de l'océan indien, Rapport de synthese du Programme d'Analyse des Systemes Educatifs de la CONFEMEN (PASEC), (Dakar: CONFEMEN).

PASEC (2004) Recrutement et formation des enseignants du premier degré au togo: Quelles priorités?, (Dakar: CONFEMEN).

PASEC (2009) Impact du statut enseignant sur les acquisitions dans le premier cycle l'enseignement fondamental public au mali, (Dakar: CONFEMEN). forthcoming document.

Raudenbush, S. and Bryk, A. (2002) *Hierarchical linear models: Applications and Analysis Methods, second edition*, (Thousand Oaks: Sage).

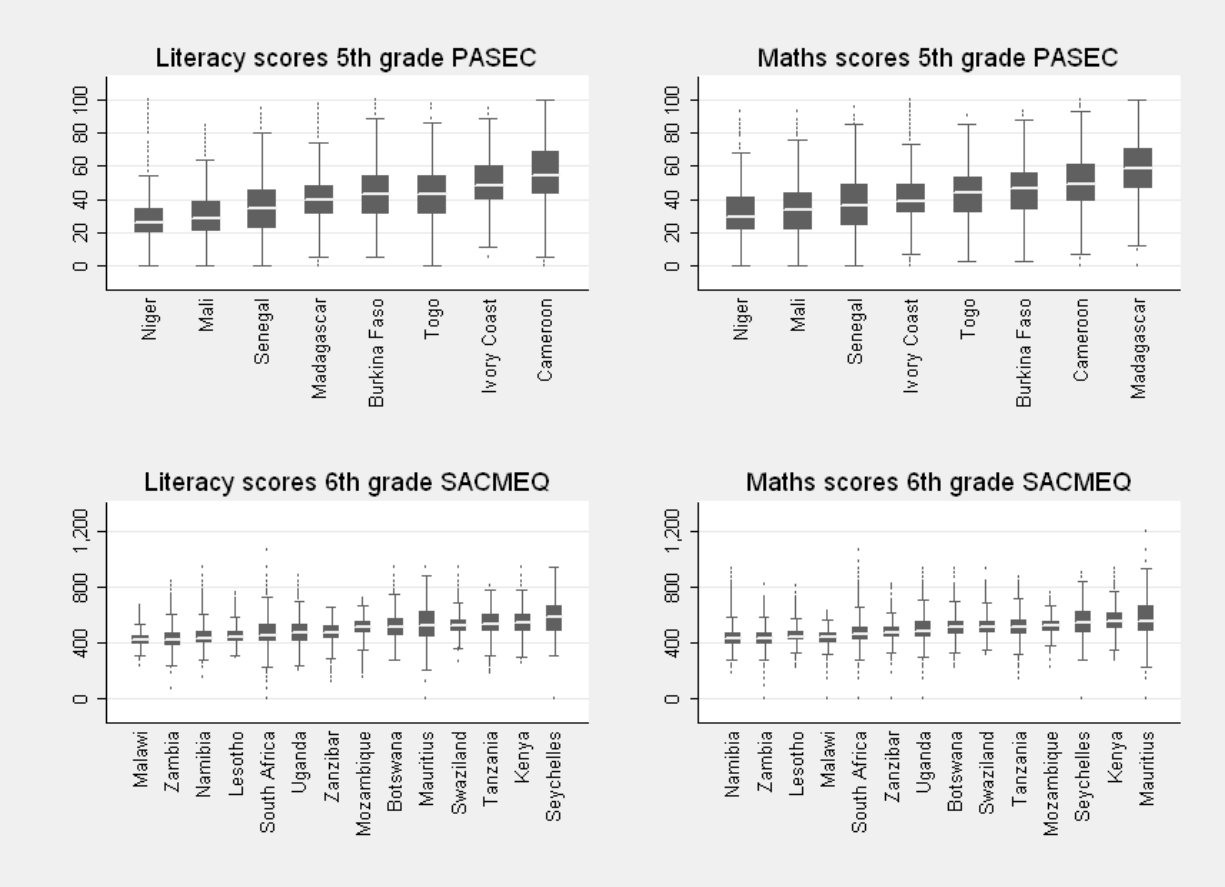
Ross, K. (1998) SACMEQ Policy Research, The Quality of Education: Some policy suggestions based on a survey of schools (various country reports), (Paris: IIEP/UNESCO).

SACMEQ (2004) Data archive for sacmeq1 and sacmeq2 projects, CD-ROM (IIEP/ UNESCO).

UNESCO (2004) Education for all (EFA) global monitoring report 2005, education for all, the quality imperative, (Paris: UNESCO). downloaded on 2/4/08 at http://portal.unesco.org

Tables, Figures, and Notes

Figure 1: Boxplots of student outcome measures across countries



Note: As described in the section on data and econometric methods student outcomes are measured on different scales in PASEC and SACMEQ. The test score for SACMEQ is coded on a scale with mean 500 and standard deviation 100. For PASEC it is the simple percentage of correct answers (0-100 per cent). Countries are ordered by the median.

Table 1: Books and Maths

each column shows results of 2 regressions		PSC 5th	PSCp 5	SCMQ 6	PSC 2	PSCp 2
textbook possession	pos sig at 5%	X	X	X	X	X
	Mag in % of s.d.	5.9 / 5.9	3.9 / 3.9	5.9 / 8.4	7.9 / 8.7	4.6 / 4.8
library	pos sig at 10%			X		
	Mag in % of s.d.			4.2 / 4.3		
books at home	pos sig at 5%	X		X	n.a.	n.a.
	Mag in % of s.d.	6.6 / 9.2		0.05 / 0.08	n.a.	n.a.

PSCp 5: PASEC 5th grade with pretest; SCMQ 6: SACMEQ 6th grade; indicators differ between PASEC and SACMEQ (see text)

Table 2: Books and Literacy

each column shows results of 2 regressions		PSC 5th	PSCp 5	SCMQ 6	PSC 2	PSCp 2
textbook possession	pos sig at 10%	In 1 reg			X	X
	Mag in % of s.d.	3.4		3.9 / 6.5	14 / 14.1	8.2 / 8.2
library	pos sig at 10%			X	X	
	Mag in % of s.d.			3.5 / 9.7	17.7 / 19.2	
books at home	pos sig at 5%	X	X	X	n.a.	n.a.
	Mag in % of s.d.	8.8 / 11	5.7 / 7.4	0.07 / 0.09	n.a.	n.a.

PSCp 5: PASEC 5th grade with pretest; SCMQ 6: SACMEQ 6th grade; indicators differ between PASEC and SACMEQ (see text)

Table 3: Teacher training, student flow and Maths

each column shows results of 2 regressions		PSC 5th	PSCp 5	SCMQ 6	PSC 2	PSCp 2
teacher acad qualification	pos sig at 10%			X		
	Mag in % of s.d.			1.8 / 3.2		
teacher training	pos sig at 10%			X		
	Mag in % of s.d.			1.9 / 2.4		
teaching in shifts	neg sig at 10%	X	X		X	X
	Mag in % of s.d.	23.5 / 24.7	14.9 / 16.2		13.2 / 16.7	12.3 / 13.9
multigrade teaching	sig at 10%			n.a.		
	Mag in % of s.d.			n.a.		

PSCp 5: PASEC 5th grade with pretest; SCMQ 6: SACMEQ 6th grade; indicators differ between PASEC and SACMEQ (see text)

Table 4: Teacher training, student flow and Literacy

each column shows results of 2 regressions		PSC 5th	PSCp 5	SCMQ 6	PSC 2	PSCp 2
teacher acad qualification	pos sig at 10%			X		
	Mag in % of s.d.			2.3 / 4.1		
teacher training	pos sig at 10%			in 1 reg		
	Mag in % of s.d.			2.3		
teaching in shifts	neg sig at 10%	X	X	In 1 reg		
	Mag in % of s.d.	19.8 / 20.8	15.1 / 17	5.8		
multigrade teaching	sig at 10%			n.a.		
	Mag in % of s.d.			n.a.		

PSCp 5: PASEC 5th grade with pretest; SCMQ 6: SACMEQ 6th grade; indicators differ between PASEC and SACMEQ (see text)

Table 5: Literacy

SACMEQ	Regr. 1 English (1) grade 6 A: 2-level model		Regr. 2 English (1) grade 6 B: survey regr.		PASEC	Regr. 3 French grade 5 A: 2-level model		Regr. 4 French grade 5 B: survey regr.		Regr. 5 French grade 5 A: 2-level model		Regr. 6 French grade 5 B: survey regr.		Regr. 7 French grade 2 A: 2-level model		Regr. 8 French grade 2 B: survey regr.		Regr. 9 French grade 2 A: 2-level model		Regr. 10 French grade 2 B: survey regr.	
	Coef.	P>|z|	Coef.	P>|t|	Variable and Range: modifications	Coef.	P>|z	Coef.	P>|t|	Coef.	P>|z|	Coef.	P>|t|	Coef.	P> z|	Coef.	P>|t|	Coef.	P> z|	Coef.	P>|t|
Initial score at the beginning of term (pre-test score)										**0.43**	0.00	**0.47**	0.00					**0.49**	0.00	**0.51**	0.00
Learning materials																					
Pupil possesses a textbook for reading						**0.62**	0.03	0.42	0.15	0.28	0.26	0.10	0.70	**3.59**	0.00	**3.53**	0.00	**2.07**	0.00	**2.07**	0.00
Availability of reading book (0=none, 0,3=shared with several peers, 0,5=shared with one peer, 1=own book)	**3.89**	0.01	**6.46**	0.01	share of books among the pupil's classmates	2.32	0.16	2.53	0.12	1.39	0.33	1.29	0.35	1.12	0.65	1.07	0.67	-0.18	0.93	-0.25	0.91
Class is equipped with wall chart	1.12	0.49	1.91	0.38																	
Teacher has access to a teacher's manual for reading	**6.54**	0.00	**4.84**	0.04		0.80	0.36	0.85	0.37	0.46	0.54	0.35	0.66	1.06	0.51	0.51	0.74	0.65	0.64	0.45	0.75
School equipment																					
Condition of school building (1=needs complete rebuilding - 5=good conditions)	**1.67**	0.05	**1.87**	0.04																	
School is equipped with a library	4.13	0.07	**4.58**	0.04		-0.32	0.80	-0.37	0.76	-0.97	0.37	-0.99	0.30	**4.49**	0.03	**4.87**	0.02	1.90	0.29	2.38	0.17
School is equipped with a first aid kit	3.63	0.12	3.88	0.12	sick-room with some equipment	-0.30	0.89	-0.15	0.93	-0.23	0.90	0.01	0.99	2.40	0.55	2.06	0.60	2.17	0.53	2.37	0.30
School has access to water	-3.11	0.22	-2.98	0.40		-0.72	0.34	-0.78	0.33	-1.01	0.12	-1.05	0.14	-0.23	0.86	-0.14	0.90	-0.07	0.95	0.07	0.95
Pupil-toilet-ratio	0.00	0.98	0.00	0.80	toilets available (dummy)	0.52	0.48	0.27	0.73	0.53	0.41	0.34	0.62	0.04	0.97	0.24	0.84	-0.49	0.64	-0.39	0.72
School is equipped with electricity	-0.52	0.85	0.23	0.93		1.14	0.23	1.06	0.20	-0.05	0.95	-0.20	0.78	2.87	0.07	2.76	0.08	0.49	0.72	0.09	0.95
School is equipped with technical resources: radio, tv,vcr,computer (0-4)	**14.08**	0.00	**12.72**	0.00																	
Class is equipped with library	**9.65**	0.00	3.54	0.10																	
Classroom is equipped with blackboard and chalk (or equivalent alternatives)	**-6.92**	0.01	-2.50	0.52		1.51	0.22	1.15	0.97	1.31	0.21	1.10	0.20	2.59	0.16	2.63	0.19	1.99	0.21	1.99	0.26
Teacher numbers and qualification																					
Class size	**3.88**	0.00	**0.84**	0.01		-0.09	0.15	-0.10	0.09	-0.04	0.41	-0.04	0.39	-0.12	0.18	-0.12	0.20	-0.10	0.21	-0.12	0.19
Class size squared	**-0.03**	0.00	**-0.01**	0.01		0.00	0.11	0.00	0.06	0.00	0.36	0.00	0.40	0.00	0.45	0.00	0.36	0.00	0.33	0.00	0.20
Teacher academic qualification (1=primary-5=tertiary)	**2.30**	0.00	**4.11**	0.00	(0=below primary - 6=at least 3 years of tertiary)	0.05	0.93	0.03	0.93	-0.19	0.50	-0.19	0.51	-0.81	0.16	-0.73	0.18	-0.65	0.19	-0.48	0.32
Teacher professional qualification (1=no teacher training - 6=three years or more)	**2.32**	0.00	1.05	0.26	teacher has received at least some professional training (dummy)	0.64	0.52	0.73	0.44	0.19	0.82	0.18	0.82	-1.51	0.30	-1.35	0.24	-0.83	0.50	-0.89	0.27
Assessment of the efficacy of in-service training by teacher (1=no such training received - 5=very effective)	**-1.83**	0.00	**-1.55**	0.01	average number of in-service training courses per year (during the last five years) (3)	**1.07**	0.02	**1.20**	0.03	0.65	0.09	0.71	0.05	0.55	0.40	0.50	0.45	0.68	0.22	0.66	0.56
Organization of student flows and study time																					
School organization in shifts	-2.93	0.45	-5.83	0.10		**-3.79**	0.00	**-3.60**	0.01	**-3.10**	0.00	**-2.75**	0.02	-2.19	0.17	-1.21	0.43	-1.30	0.34	-0.73	0.59
Multi-grade teaching						0.31	0.63	-0.13	0.94	0.62	0.51	0.74	0.64	-0.83	0.71	-1.03	0.61	-0.95	0.62	-1.01	0.62
Pupil repeats current grade (3)	**-11.16**	0.00	**-12.11**	0.00		**1.09**	0.00	0.62	0.13	**0.60**	0.03	0.32	0.38	**-0.96**	0.02	-0.92	0.14	**-1.38**	0.00	**-1.26**	0.01
Pupil's overall grade repetition (1=never - 4=three or more times)	**-7.67**	0.00	**-10.83**	0.00	number of grades repeatec before current grade	**-2.06**	0.00	**-2.52**	0.00	**-1.39**	0.00	**-1.46**	0.00	**-4.66**	0.00	**-5.26**	0.00	**-3.28**	0.00	**-3.29**	0.00
Pupil is never missing school	**16.15**	0.00	**14.81**	0.01																	
Pupil has no health problems	-0.12	0.98	-3.92	0.45																	
Teacher arrives late (1=never - 3=often)	**-6.06**	0.01	**-5.81**	0.04																	
Teacher absenteeism (1=never - 3=often)	-3.08	0.09	-3.47	0.07	absence in days per month (0-25)	-0.25	0.08	-0.21	0.07	-0.14	0.22	-0.12	0.23	0.28	0.12	0.24	0.24	0.22	0.15	0.17	0.30
Number of lost official school days in the previous school year	0.06	0.63	0.06	0.66																	
Institutional variables																					
School type (1=government, 2=privat)	**9.60**	0.02	7.13	0.12																	
Parents' or community's contribution to class equipment of furniture, books and other materials (0=none-4)	**2.14**	0.01	**2.28**	0.01	parents easily mobilized for school issues (dummy)	0.29	0.68	0.32	0.66	-0.24	0.69	-0.29	0.65	-0.35	0.77	-0.34	0.77	-0.06	0.95	-0.14	0.89
Parents' or community's payment of exam fees, additional teacher salaries or bonuses (0=none -5)	0.54	0.61	0.34	0.78																	
Teacher works on a non-civil servant contract						0.74	0.50	1.32	0.25	0.26	0.78	0.55	0.59	-0.27	0.87	-0.19	0.91	-1.52	0.29	-2.04	0.18
Teacher gets advice from principal at least once a year	**-5.76**	0.02	-3.36	0.41	frequent exchange among teachers	-0.75	0.37	-0.54	0.51	-0.67	0.35	-0.47	0.60	-0.18	0.90	-0.32	0.83	0.70	0.57	0.60	0.63
Teacher considers promotion opportunities as very important	**-5.92**	0.00	-0.92	0.72																	
School inspection in the year 2000	-0.88	0.80	-2.33	0.29	in the year of the survey	**1.13**	0.20	**1.24**	0.17	0.79	0.30	0.88	**0.24**	-1.55	0.26	-1.84	0.16	-0.66	0.58	-0.63	0.59

Table 5 continued

Controls					Controls													
Student characteristics and family background																		
Pupil is female	4.03	0.00	4.20	0.00		-0.30	0.16	0.02	0.95	0.03	0.89	0.26	0.29	-0.06	0.86	0.72	0.11	0.38	0.17	**0.98**	0.01
Pupil's age in months	**-0.27**	0.00	**-0.22**	0.00	in years	**-0.76**	0.00	**-0.83**	0.00	**-0.59**	0.00	**-0.63**	0.00	**0.65**	0.00	**0.58**	0.03	-0.04	0.78	-0.02	0.94
Pupil's home possessions (e.g. newspaper, tv, fridge, etc.; 0-14)	**0.98**	0.00	**0.70**	0.01	(0-8)	**0.36**	0.00	**0.34**	0.00	**0.26**	0.00	**0.24**	0.00	**0.71**	0.00	**0.69**	0.00	**0.46**	0.00	**0.44**	0.00
Pupil' housing conditions (3=bad - 16=good)	**1.69**	0.00	**1.27**	0.00																	
Pupil's meals per day (1=none at all - 12=3x every day)	**3.43**	0.00	**3.55**	0.00	(0-3)	1.58	0.00	1.57	0.00	**0.78**	0.00	0.09	0.82	0.38	0.36	0.51	0.55	0.16	0.62	-0.35	0.63
Parental education (2=none - 12=both some post-secondary)	**2.35**	0.00	**2.67**	0.00	Parental literacy (0=none - 2=both are literate)	**0.58**	0.00	**0.74**	0.01	0.21	0.17	0.24	0.32								
Number of books at pupil's home (0-250)	**0.07**	0.00	**0.09**	0.00	Pupil has some books at home (3)	1.60	0.00	**2.00**	0.00	1.04	0.00	**1.34**	0.00								
Pupil speaks English at home	**23.86**	0.00	**27.04**	0.00	French (3)	1.72	0.00	1.34	0.03	**0.98**	0.00	0.70	0.23	**3.22**	0.00	**3.41**	0.00	**1.22**	0.00	**2.15**	0.01
Pupil gets help with homework						**-0.72**	0.00	-1.21	0.00	**-0.53**	0.01	**-0.91**	0.00	**1.96**	0.00	**1.63**	0.01	0.50	0.13	-0.24	0.67
Socio economic status of classmates (1-15)	**6.92**	0.00	**6.58**	0.00	(0-8)	1.33	0.00	1.35	0.00	1.02	0.00	**0.99**	0.00	0.44	0.39	0.65	0.21	-0.07	0.87	0.03	0.94
Teacher characteristics																					
Teacher is female	**-3.15**	0.03	0.35	0.86		0.24	0.78	0.58	0.52	-0.32	0.66	-0.11	0.89	0.81	0.51	0.90	0.46	0.68	0.40	1.00	0.34
Teacher job experience (in years)	**0.22**	0.01	0.19	0.19		0.09	0.09	0.09	0.12	0.07	0.11	0.07	0.16	-0.11	0.17	-0.09	0.25	-0.09	0.19	-0.07	0.32
Teacher speaks teaching language at home (3)						-0.32	0.53	-0.28	0.58	0.02	0.87	0.05	0.90	0.13	0.88	0.25	0.75	-0.07	0.92	-0.04	0.95
Teacher speaks oca language						0.86	0.28	0.56	0.49	0.69	0.69	0.41	0.57	1.32	0.32	**1.55**	0.24	**-0.17**	0.88	-0.07	0.95
Pedagocial tools																					
Frequency of reading test (1=none - 6=once or more per week)	**24.27**	0.00	**17.05**	0.02																	
Squared frequency of reading test	**-2.77**	0.00	**-2.07**	0.01																	
Frequency teacher corrects reading-homework (1=no homework - 5=always)	**1.62**	0.00	**1.10**	0.05																	
Other controls																					
School participates in a pilot project, exchange program etc.						0.82	0.45	0.67	0.44	-0.19	0.79	-0.13	0.86	1.70	0.20	**1.63**	0.27	1.66	0.15	1.75	0.14
School size (number of pupils)	**-0.01**	0.00	0.00	0.68		**-0.01**	0.00	**-0.01**	0.00	**-0.01**	0.00	**0.00**	0.01	0.00	0.16	**-0.01**	0.02	0.00	0.08	**-0.01**	0.02
School location (1=isolated-4=city)	**3.83**	0.02	**4.98**	0.00	dummy (0=rural 1=urban)	1.50	0.11	1.48	0.13	1.42	0.08	1.51	0.08	2.22	0.14	2.07	0.17	1.91	0.14	1.87	0.15
Class environement (e.g. disturbance, theft,etc.; 0=never-17)	0.19	0.55	0.34	0.36																	
Country fixed effects																					
Botswana	**262.66**	0.00	**338.90**	0.00	Burkina Faso	**42.54**	0.00	**43.65**	0.00	**27.03**	0.00	**28.34**	0.00	**48.79**	0.00	**48.40**	0.00	**45.02**	0.00	**45.41**	0.00
Kenya	**292.13**	0.00	**372.21**	0.00	Cameroon	**52.15**	0.00	**53.01**	0.00	**31.40**	0.00	**31.73**	0.00	**57.53**	0.00	**57.25**	0.00	**47.02**	0.00	**47.06**	0.00
Lesotho	**194.33**	0.00	**286.19**	0.00	Côte d'Ivoire	**46.08**	0.00	**47.44**	0.00	**27.77**	0.00	**28.84**	0.00	**46.81**	0.00	**46.62**	0.00	**47.21**	0.00	**40.29**	0.00
Malawi	**226.11**	0.00	**304.04**	0.00	Madagascar	**41.94**	0.00	**38.96**	0.00	**26.20**	0.00	**26.91**	0.00	**50.02**	0.00	**50.15**	0.00	**40.60**	0.00	**41.25**	0.00
Mauritius	**166.02**	0.00	**257.09**	0.00	Mali	**28.42**	0.00	**29.78**	0.00	**18.50**	0.00	**20.41**	0.00	**29.85**	0.00	**28.33**	0.00	**30.73**	0.00	**30.81**	0.00
Mozambique	**288.04**	0.00	**376.36**	0.00	Niger	**27.02**	0.00	**27.72**	0.00	**18.55**	0.00	**20.27**	0.00	**33.49**	0.00	**34.22**	0.00	**35.37**	0.00	**37.10**	0.00
Namibia	**193.70**	0.00	**276.00**	0.00	Senegal	**31.77**	0.00	**32.37**	0.00	**23.38**	0.00	**24.82**	0.00	**33.43**	0.00	**33.33**	0.00	**33.56**	0.00	**34.81**	0.00
Seychelles	**227.13**	0.00	**301.20**	0.00	Togo	**43.56**	0.00	**44.81**	0.00	**25.41**	0.00	**26.28**	0.00	**51.48**	0.00	**51.67**	0.00	**41.94**	0.00	**42.74**	0.00
South Africa	**199.21**	0.00	**290.50**	0.00																	
Swaziland	**268.12**	0.00	**351.00**	0.00																	
Tanzania	**316.80**	0.00	**401.80**	0.00																	
Uganda	**254.72**	0.00	**336.27**	0.00																	
Zambia	**206.73**	0.00	**286.71**	0.00																	
Zanzibar	**242.59**	0.00	**326.95**	0.00																	
n	37383		37383			13845		13845		13784		13784		13815		13815		13894		13894	
Specified strata (countries)			14			8		8		8		8		8		8		8		8	
Specified PSUs (schools)	2074		2074			882		882		882		882		891		891		891		891	
R-squared, between (2)	43.4%					52.3%				64.7%				31.9%				49.2%			
R-squared, within (2)	4.7%					4.5%				21.8%				3.1%				23.7%			
R-squared, total (2)	78.2%		40.7%			32.5%		32.7%		46.5%		46.7%		19.1%		19.1%		37.5%		37.6%	

(1) Exceptions: Portuguese for Mozambique, Swahili for Tanzania (mainland) and Zanzibar.

(2) Pseudo R-squared in case of Maximum likelihood estimations (Regression 1). The R-squared refers to a model with constant (omitting one country fixed effect). Note that the R-squared between schools appears very high because it includes the impact of the country dummies.

(3) Variable missing for one country and imputed using the linear regress on on related variables in the cross-country sample.

coefficients significant at the 5% level are bold

Table 6: Mathematics

SACMEQ	Regr. 11 Math grade 6 A: 2-level model		Regr. 12 Math grade 6 B: survey Regr.		PASEC	Regr. 13 Math grade 5 A: 2-level model		Regr. 14 Math grade 5 B: survey Regr.		Regr. 15 Math grade 5 A: 2-level model		Regr. 16 Math grade 5 B: survey Regr.		Regr. 17 Math grade 2 A: 2-level model		Regr. 18 Math grade 2 B: survey Regr.		Regr. 19 Math grade 2 A: 2-level model		Regr. 20 Math grade 2 B: survey Regr.	
Variable and Range	Coef.	P>|z|	Coef.	P>|t	**Variable and Range: modifications**	Coef.	P>|z|	Coef.	P>|t|	Coef.	P>|z|	Coef.	P>|t|	Coef.	P>|z|	Coef.	P>|t|	Coef.	P>|z|	Coef.	P>|t|
Initial score at the beginning of term (pre-test score)										**0.39**	0.00	**0.42**	0.00					**0.57**	0.00	**0.48**	0.00
Learning materials																					
Pupil possesses a textbook for math						**1.08**	0.00	**1.08**	0.00	**0.71**	0.00	**0.71**	0.01	**2.11**	0.00	1.91	0.00	**1.12**	0.01	**1.17**	0.01
Availab ility of math book (0=none, 0.3=shared with several peers 0.5=shared with one peer, 1=own book)	**5.94**	0.00	**8.43**	0.00	share of books among the pupil's class	3.09	0.06	2.91	0.11	2.50	0.09	2.07	0.21	**3.95**	0.05	3.32	0.10	2.54	0.16	1.98	0.26
Class is equipped with wall char:	0.80	0.65	0.55	0.80																	
Teacher has access to a teache"s manual for math	**1.88**	0.25	**6.74**	0.00		0.48	0.55	0.70	0.42	0.27	0.70	0.56	0.49	**1.78**	0.20	'.85	0.15	'.22	0.32	1.36	0.27
School equipment																					
Condition of school building (1=needs complete rebuilding - 5=good conditions)	**2.44**	0.01	**2.42**	0.01																	
School is equipped with a library	2.98	0.22	2.70	0.26		0.00	1.00	-0.20	0.87	-0.76	0.51	-1.06	0.33	**1.71**	0.32	2.09	0.18	-0.66	0.66	0.21	0.89
School is equipped with a first aid kit	2.77	0.27	1.83	0.52	sick-room with some equipment	2.21	0.32	2.28	0.26	2.34	0.23	2.41	0.14	3.58	0.27	3.67	0.28	2.36	0.42	3.42	0.23
School has access to water	**-4.81**	0.08	-3.03	0.27		-0.35	0.66	-0.56	0.50	-0.34	0.63	-0.51	0.39	-0.81	0.44	-0.78	0.43	0.01	0.99	-0.23	0.80
Pupil-toilet-ratio	0.00	0.67	0.00	0.75	toilets available (dummy)	-0.07	0.93	-0.26	0.75	0.23	0.73	0.13	0.86	-0.39	0.70	-0.38	0.70	-0.09	0.93	-0.14	0.87
School is equipped with electricity	**-5.84**	0.04	-4.26	0.10		0.97	0.32	1.06	0.24	0.01	0.99	0.00	1.00	**1.75**	0.18	'.61	0.20	-0.10	0.93	-0.01	1.00
School is equipped with technical resources: radio, tv,vcr,computer (0-4)	**13.67**	0.00	**12.90**	0.00																	
Class is equipped with library	**4.27**	0.01	4.20	0.08																	
Classroom is equipped with blackboard and chalk (or equivalent alternatives)	**6.24**	0.03	5.69	0.11		0.60	0.53	0.61	0.57	0.22	0.84	0.14	0.88	0.83	0.58	0.54	0.72	'.62	0.23	1.49	0.20
Teacher numbers and qualification																					
Class s ze	**3.29**	0.00	-0.01	0.96		-0.02	0.81	-0.03	0.61	0.01	0.84	-0.01	0.89	-0.05	0.46	-0.05	0.48	-0.03	0.64	-0.04	0.53
Class s ze squared	**-0.03**	0.00	**0.00**	0.77		0.00	0.74	0.00	0.60	0.00	0.84	0.00	0.97	0.00	0.90	0.00	0.77	0.00	0.89	0.00	0.63
Teacher academic qualification (1=primary-5=tertiary)	**1.75**	0.04	**3.20**	0.01	(0=below primary - 6=at least 3 years of tertiary)	0.08	0.81	0.16	0.64	0.03	0.92	0.12	0.71	-0.62	0.19	-0.56	0.19	-0.61	0.15	-0.44	0.29
Teacher professional qualification (1=no teacher training - 6=three years or more)	**2.37**	0.00	**1.87**	0.05	teacher has received at least some professional training (dummy)	0.80	0.45	0.78	0.43	0.48	0.60	0.56	0.53	-0.31	0.79	-0.26	0.83	0.66	0.53	0.54	0.61
Assessment of the efficacy of in-service training by teacher (1=no such training received - 5=very effective)	-0.14	0.76	-0.20	0.76	average number of in-service training courses per year (during the last five years) (2)	0.85	0.07	0.94	0.09	0.59	0.15	0.62	0.14	0.90	0.09	0.94	0.11	**0.95**	0.05	1.00	0.07
Organization of student flows and study time																					
School organization in shifts	0.57	0.69	-2.48	0.45		**-4.49**	0.00	**-4.28**	0.00	**-2.95**	0.01	**-2.72**	0.04	**-4.06**	0.00	**-3.21**	0.01	**-3.37**	0.00	**-2.99**	0.01
Multi-grade teaching						0.45	0.77	0.19	0.92	0.91	0.50	1.02	0.51	-0.33	0.86	-0.34	0.85	0.45	0.78	0.37	0.85
Pupil repeats current grade (2)	**-8.66**	0.00	**-8.88**	0.00		**1.91**	0.00	**1.46**	0.00	**0.79**	0.00	0.51	0.21	0.32	0.46	0.50	0.38	-0.49	0.16	0.03	0.95
Pupil's overall grade repetition (1=never - 4=three or more times)	**-4.82**	0.00	**-9.32**	0.00	number of grades repeated before current grade	**-1.72**	0.00	**-2.23**	0.00	**-1.17**	0.00	**-1.47**	0.00	**-5.12**	0.00	**-5.27**	0.00	**-3.59**	0.00	**-3.81**	0.00
Pupil is never missing school	**28.15**	0.00	**24.29**	0.00																	
Pupil has no health problems	2.87	0.58	1.96	0.79																	
Teacher arrives late (1=never - 3=often)	**-7.95**	0.00	**-7.04**	0.01																	
Teacher absenteeism (1=never - 3=often)	0.16	0.94	-0.43	0.83	absence in days per month (0-25)	**-0.33**	0.02	**-0.29**	0.02	**-0.24**	0.05	**-0.22**	0.04	0.25	0.08	0.25	0.09	0.10	0.43	0.13	0.30
Number of lost official school days in the previous school year	-0.06	0.69	-0.02	0.87																	
Institutional variables																					
School type (1=government, 2=privat	3.67	0.42	1.08	0.84																	
Parents' or community's contribution to class equipment of furniture, books and other materials (0=none-4)	**1.81**	0.04	**2.09**	0.02	parents easily mobilized for school issues (dummy)	1.18	0.11	1.29	0.09	0.62	0.34	0.48	0.47	0.11	0.91	0.00	1.00	'.08	0.21	0.69	0.39
Parents' or community's payment of exam fees, additional teacher salaries or bonuses (0=none -5)	-0.82	0.47	-0.47	0.73																	
Teacher works on a non-civil servant contract						0.59	0.61	1.33	0.30	0.24	0.81	0.61	0.60	-0.68	0.62	-0.66	0.63	0.21	0.42	-1.18	0.37
Teacher gets advice from principal at least once a year	0.96	0.70	-0.77	0.84	frequent exchange among teachers	0.64	0.46	0.75	0.40	0.56	0.47	0.55	0.49	-0.72	0.54	-0.90	0.43	0.63	0.55	0.36	0.72
Teacher considers promotion opportunities as very important	**-6.67**	0.00	-1.85	0.47																	
School inspection in the year 2000	-0.30	0.67	-3.49	0.16	in the year of the survey	**1.99**	0.03	**2.13**	0.02	**1.72**	0.04	**1.92**	0.02	-0.21	0.86	-0.16	0.88	-0.40	0.70	-0.29	0.76

Table 6 continued

Controls					Controls											
Student characteristics and family background																
Pupil is female	**-8.48**	0.00	**-7.93**	0.00		**-1.39**	0.00	**-0.90**	0.00	**-0.68**	0.00	-0.16	0.53	**-1.69**	0.00	-1.10	0.01	**-0.87**	0.00	-0.58	0.12
Pupil's age in months	**-0.27**	0.00	**-0.22**	0.00	in years	**-0.40**	0.00	-0.20	0.15	**-0.40**	0.00	**-0.24**	0.04	**1.11**	0.00	**1.10**	0.00	0.03	0.86	0.11	0.60
Pupil's home possessions (e.g. newspaper, tv, fridge, etc.; 0-14)	**1.19**	0.00	**0.92**	0.00	(0-8)	**0.20**	0.00	0.16	0.05	**0.13**	0.03	0.11	0.15	**0.66**	0.00	**0.64**	0.00	**0.37**	0.00	**0.40**	0.00
Pupil' housing conditions (3=bad - 16=good	**1.02**	0.00	**0.59**	0.02																	
Pupil's meals per day (1=none at all - 12=3x every day	**2.81**	0.00	**3.11**	0.00	(0-3)	**1.19**	0.00	**1.54**	0.00	0.18	0.41	-0.14	0.73	0.66	0.14	0.31	0.67	-0.01	0.99	-0.48	0.42
Parental education (2=none - 12=both some post-secondary)	**1.45**	0.00	**1.80**	0.00	Parental literacy (0=none - 2=both)	**0.40**	0.02	**0.67**	0.01	**0.30**	0.04	0.35	0.13								
Number of books at pupil's home (0-250)	**0.05**	0.00	**0.08**	0.00	Pupil has some books at home (2)	**1.21**	0.00	**1.68**	0.00	0.32	0.20	0.52	0.18								
Pupil speaks English at home	**22.25**	0.00	**24.02**	0.00	French (2)	**1.25**	0.00	1.07	0.07	**0.59**	0.04	0.74	0.18	**2.05**	0.00	**2.71**	0.00	**0.86**	0.07	**2.59**	0.00
Pupil gets help with homework						-0.39	0.10	**-1.00**	0.01	-0.01	0.95	-0.46	0.16	**2.96**	0.00	**2.89**	0.00	**1.30**	0.00	**1.03**	0.04
Socio economic status of classmates (1-15)	**4.88**	0.00	**4.32**	0.00	(0-8)	0.41	0.24	**0.44**	0.22	0.19	0.54	0.21	0.56	0.58	0.17	0.79	0.06	**0.78**	0.04	**0.91**	0.01
Teacher characteristics																					
Teacher is female	1.27	0.40	-1.49	0.51		-0.93	0.29	-0.62	0.49	-1.45	0.06	-1.37	0.09	1.90	0.06	1.84	0.07	**1.97**	0.03	**1.98**	0.03
Teacher job experience (in years)	**0.30**	0.00	**0.23**	0.07		0.05	0.37	0.07	0.24	0.05	0.25	0.07	0.16	-0.13	0.06	-0.11	0.08	-0.12	0.05	-0.10	0.07
Teacher speaks teaching language at home (2)						-0.48	0.37	-0.55	0.30	-0.16	0.73	-0.11	0.82	**0.47**	0.48	0.52	0.42	0.23	0.70	0.31	0.58
Teacher speaks local language						0.36	0.67	0.11	0.90	0.44	0.56	0.23	0.78	1.71	0.12	1.84	0.09	0.81	0.41	0.99	0.31
Pedagogcial tools																					
Frequency of math test (1=none-6=once or more per week)	-0.68	0.91	-10.50	0.25																	
Squared frequency of math test	0.00	1.00	1.11	0.26																	
Frequency teacher corrects math-homework (1=no homework - 5=always)	**3.13**	0.00	**3.31**	0.00																	
Other controls																					
School participates in a pilot project, exchange program etc						0.44	0.60	0.60	0.48	-0.66	0.38	-0.55	0.46	**0.44**	0.69	0.33	0.79	-0.33	0.74	-0.42	0.67
School size (number of pupils)	**-0.01**	0.00	**0.00**	0.43		**-0.01**	0.00	**0.00**	0.00	**0.00**	0.00	**0.00**	0.00	0.00	0.49	0.00	0.53	0.00	0.65	0.00	0.97
School location (1=isolated-4=city)	0.99	0.53	**2.68**	0.10	dummy (0=rural, 1=urban)	**1.22**	0.21	**1.20**	0.22	0.98	0.25	**1.03**	0.25	**1.33**	0.28	**1.26**	0.30	-0.15	0.90	0.13	0.90
Class environement (e.g. disturbance, theft, etc.; 0=never-17)	0.41	0.23	**0.52**	0.16																	
Country fixed effects																					
Botswana	**341.48**	0.00	**422.23**	0.00	Burkina Faso	**44.54**	0.00	**41.41**	0.00	**32.06**	0.00	**30.27**	0.00	**37.77**	0.00	**37.90**	0.00	**28.06**	0.00	**30.74**	0.00
Kenya	**396.38**	0.00	**483.11**	0.00	Cameroon	**46.10**	0.00	**43.07**	0.00	**27.69**	0.00	**25.76**	0.00	**41.00**	0.00	**41.20**	0.00	**21.97**	0.00	**25.97**	0.00
Lesotho	**277.64**	0.00	**374.14**	0.00	Côte d Ivoire	**46.37**	0.00	**31.80**	0.00	**19.36**	0.00	**17.35**	0.00	**24.68**	0.00	**25.25**	0.00	**13.78**	0.00	**16.89**	0.00
Malawi	**306.58**	0.00	**387.15**	0.00	Madagascar	**56.95**	0.00	**53.30**	0.00	**35.79**	0.00	**33.43**	0.00	**48.32**	0.00	**49.22**	0.00	**23.75**	0.00	**29.80**	0.00
Mauritius	**317.79**	0.00	**416.53**	0.00	Mali	**31.51**	0.00	**28.11**	0.00	**21.52**	0.00	**19.84**	0.00	**24.64**	0.00	**24.39**	0.00	**17.18**	0.00	**19.54**	0.00
Mozambique	**384.28**	0.00	**480.83**	0.00	Niger	**28.40**	0.00	**24.67**	0.00	**21.26**	0.00	**19.56**	0.00	**23.29**	0.00	**24.36**	0.00	**15.55**	0.00	**18.65**	0.00
Namibia	**262.78**	0.00	**352.72**	0.00	Senegal	**34.64**	0.00	**30.96**	0.00	**29.02**	0.00	**27.45**	0.00	**25.83**	0.00	**26.58**	0.00	**25.92**	0.00	**27.95**	0.00
Seychelles	**306.44**	0.00	**386.36**	0.00	Togo	**41.19**	0.00	**38.28**	0.00	**22.37**	0.00	**20.33**	0.00	**35.92**	0.00	**36.73**	0.00	**19.50**	0.00	**23.56**	0.00
South Africa	**287.46**	0.00	**385.07**	0.00																	
Swaziland	**348.13**	0.00	**437.59**	0.00																	
Tanzania	**383.03**	0.00	**471.52**	0.00																	
Uganda	**371.31**	0.00	**454.44**	0.00																	
Zambia	**289.95**	0.00	**375.09**	0.00																	
Zanzibar	**328.31**	0.00	**423.73**	0.00																	
n	36023		36023			14308		14308		14233		14233		13798		13798		13748		13748	
Specified strata (countries)			14			8		8		8		8		8		8		8		8	
Specified PSUs (schools)	2002		2002			882		882		882		882		891		891		891		891	
R-squared, between (1)	40.8%					45.5%				58.2%				37.4%				47.5%			
R-squared, within (1)	1.5%					2.8%				22.3%				2.6%				26.0%			
R-squared, total (1)	79.0%		38.5%			28.8%		28.9%		43.4%		43.5%		18.7%		18.8%		35.8%		36.3%	

(1) Pseudo R-squared in case of Maximum likelihood estimations (Regression 11). The R-squared refers to a model with constant (omitting one country fixed effect). Note that the R-squared between schools appears very high because it includes the impact of the country dummies.

(2) Variable missing for one country and imputed using the linear regression on related variables in the cross-country sample.

coefficients significant at the 5% level are bold

Table 7: PASEC 5th grade single country regressions (number of significant regressions at 5, 10 or20%)

Maths no pretest		text book possession	teacher academic qualification	teacher professional qualification	double shift organization	pupil has books at home
positive significant at	20%					1
	10%	1		1		1
	5%	1	1			2
negative significant at	20%	1	1			
	10%				2	
	5%		1		2	
insignificant at	20%	5	5	7	3	4
Maths with pretest						
positive significant at	20%					
	10%	1	1	1		
	5%	1				1
negative significant at	20%	1			1	
	10%		2		1	
	5%				2	1
insignificant at	20%	5	5	7	3	6
Literacy no pretest						
positive significant at	20%	2				
	10%		1	1	1	1
	5%			1		4
negative significant at	20%			1	1	1
	10%		1			
	5%	1			2	
insignificant at	20%	5	6	5	3	4
Literacy with pretest						
positive significant at	20%	2				
	10%		1			
	5%			1	1	3
negative significant at	20%				2	1
	10%		1			
	5%	1		1	2	1
insignificant at	20%	5	6	6	2	3

Remark: Double shift organization does not exist for Togo

Table 8: SACMEQ 6th grade single country regressions (number of significant regressions at 5, 10 or 20%)

Maths		availability of book	teacher academic qualification	teacher professional qualification	double shift organization	number of books at home	classroom library	teacher's manual
positive sig at	20%		1	1		1	3	
	10%			2		1	1	2
	5%	4		1	1	4	2	4
negative sig at	20%	1	1	1		1	1	
	10%	1	1					
	5%			1	1	2		
insignificant at	20%	8	11	8	6	5	7	8
Literacy								
positive sig at	20%	1	1	3		1		
	10%		3			1	1	1
	5%	3		2		5	2	2
negative sig at	20%		1				1	
	10%			1	1	1	1	
	5%	1	1		2	1		
insignificant at	20%	9	8	8	5	5	9	11

Remark: no variation in double shift teaching in 6 countries

1 For a more detailed discussion of education production functions see Glewwe and Kremer (2006)
2 More details regarding differences in sampling are discussed in the Appendix.
3 These robustness checks are not reported here, but results are available from the article's online annex.
4 Even if an impact of educational attainment on student achievement was found,a policy to increase teacher education would have to be considered with care as costs in terms of salaries sharply increase with the completion of the upper secondary final examination. In Burkina Faso in 1999, for example, teachers with a baccalauréat earned 28 per cent more than their colleagues without baccalauréat (averaged over the income groups for different final marks and tenure). In absolute numbers the difference of the incomes (again averaged over income groups) was 380 Euros per year (Ministère de l'économie et de finance BF, 1999).
5 See for example Bernard, Simon and Vianou (2005) on the effects of grade repetition in Africa.