SCHOOLING QUALITY IN A CROSS SECTION OF COUNTRIES

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ABSTRACT

We investigate the determinants of educational quality in a panel data set that includes output and input measures for a broad number of countries. The results show that family inputs and school resources are closely related to school outcomes, as measured by internationally comparable test scores, repetition rates, and drop-out rates. Family characteristics, such as income and education of parents, have strong effects on student performance. The findings also indicate that more school resources - especially smaller class sizes but probably also higher teacher salaries and greater school length - enhance educational outcomes.

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I. Introduction

The role of human capital has been emphasized in the recent literature on economic growth. Cross-country regressions have found that various measures of schooling are important determinants of per capita growth. One problem with these previous studies, however, is that the schooling variables, such as enrollment ratios and average years of attainment, are imperfect measures of the educational component of human capital. For example, they measure only the quantity of schooling, not the quality.

Although the quality of schooling varies substantially across countries, it is difficult to measure this quality for a broad number of countries. Conceptually, the quality of education would be reflected in the performance of students and graduates. For instance, the value added from school can be measured by labor market performance, such as extra earnings or employment of educated workers. One problem with this measure is that labor market performance depends on external circumstances, rather than solely on schooling (see Psacharopoulous and Woodhall [1985, p.205]).

Another indicator of schooling quality is students' scores on internationally comparable tests of achievement in knowledge, skills, behavior, and attitudes. Effects of non-school inputs, such as parental background, would have to be held constant to isolate the effect of schooling on test scores. However, this task is likely to be easier than for labor-market outcomes, which are less directly connected to schooling and are more influenced by other factors, such as physical capital and infrastructure.

Many studies find that tests of cognitive achievement are good predictors of students' future earnings (see, for example, Bossier, Knight, and Sabot [1985], and Bishop [1989, 1992]). Evidence also shows that test scores are highly correlated with economic performance in aggregate data. For example, Hanushek and Kim (1995) find that test scores are positively related to growth rates of real per capita GDP in cross-country regressions. This result indicates that the quality of schooling, in addition to the quantity, is an important ingredient of human capital.

In this paper we investigate the cross-country determinants of educational quality, as revealed by test scores and some other measures. Although many studies have investigated the relationship between test scores and inputs from schools, families, and communities, these studies are mostly based on cross-section data within a country. It is not clear, however, how we should interpret a positive association between test scores and school inputs because of the endogeneity of the input choice. Mobility of residents in search of better schools makes this problem more serious within a country than across countries. That is, the reverse-causality problem would be more severe in cross-region data within a country than in cross-country data.

Cross-country studies are scarce because of the limited availability of internationally-comparable data. Hanushek and Kim(1995) recently constructed a cross-section data set of test scores for 39 countries. They found, using 31 observations in cross-country regressions, that conventional measures of school resources, such as teacher-pupil ratios and educational expenditures, do not have strong effects on test performance.

In this paper, we extend the study of Hanushek and Kim to investigate the relationship between test scores and various measures of school and family inputs. One difference in our work is that we use a panel of test scores in the regressions. Hanushek and Kim combined the available science and mathematics test scores into a single score for each country. Instead, we have compiled test scores on the examinations in science, mathematics, and reading tests for students of different age groups in various years for up to 58 countries. We then constructed a panel of 214 observations by combining these test scores with the schooling input data that were recently compiled by Barro and Lee (1996).

We also consider school repetition and dropout rates as additional measures of educational quality. We then investigate the effects of family characteristics and school resources on these two school outcome measures.

II. Conceptual Framework

The relationship between school output and inputs can be analyzed with an education production function that relates the output of education to various inputs. This education production function can be specified as

$$Q = Q(F, R) + \epsilon \qquad (1)$$

where Q denotes schooling quality; F, family factors; R, resources used by schools; and ϵ denotes unmeasured factors influencing schooling quality.

A. Educational Outcomes—Test Scores, Dropout Rates, and Repetition Rates

The quality of educational output can be measured by the achievement of students and graduates. Education has impacts on various dimensions of cognitive competence, including basic numeracy, literacy (reading and writing), and the ability of problem solving, as well as general scientific understanding of the world (Lockheed et, al [1991, p.5]). These cognitive skills affect an individual's productive behavior.

The cognitive achievement of students can be measured by examination scores on international tests. The cross-national comparative studies have assessed learning achievement in specific areas, especially mathematics and science, administered to national samples of students of the same ages or school grades. In the tests, students of the same age or grade group were asked questions that reflected each country's national curriculum but were also common to the curricula of all the countries that participated in the tests. The tests are therefore designed to ensure international comparability. Hence, the test scores would capture the cross-country variations in cognitive skills of the students and thereby the differences in the quality of the future labor force.

We think of school dropout and repetition rates as additional measures of educational outcomes. Low repetition and high dropout rates can be the results of poor academic achievement. Therefore, we view these variables as determined along with test scores by the family factors and school inputs that we discuss below. The relationship between grade repetition and student achievement is controversial. Repetition and student achievement could be positively correlated if repetition remedied inadequate achievement and improved the performance of slow learners. However, several studies have suggested that there is no educational advantage from making low achievers repeat grades.

B. Family Factors

Academic performance of students is affected by nonschool factors and family background of the students. Family background affects not only the probability that children enroll in, attend, and complete school, but also the learning of children in school (Lockheed, et al [1991, p.73]). A student surrounded by a more stimulating home environment would learn more quickly in school.

Many previous studies suggest that family background and socioeconomic factors are more important determinants of student achievement than are school resources (Hanushek [1986, 1995]). Some studies present evidence that a school's output depends largely on characteristics such as family background and children's innate ability, rather than school inputs.

Three key variables that reflect family background are family income, parents' (particularly father's) education level, and father's occupation (Psacharopoulos and Woodhall [1985, p.114]). The education level of parents would have a strong effect on student achievement: for instance, parents with higher schooling would have a stronger demand for education and would thus provide more materials and school-related activities for their children. Family income also determines the demand for education. More household income means, in addition, that children have better nutrition and, hence, an increased ability to learn. Several studies document this relation—see Pollitt (1990) for a summary of nine studies that report a significant relation between protein-energy malnutrition and cognitive test scores or school performance of students.

In the aggregate, we would also find across countries that higher average income leads—through the political process—to more resources provided for public education. Since our measures of school resources are imperfect, we may therefore overestimate the direct effect of family factors on school outcomes. That is, the family factors would proxy for unobserved differences in school inputs.

C. School Resources

Conceptually, student achievement can be influenced by resources available to the students in schools. These resources can be measured by various indicators, such as pupil-teacher ratios, expenditure per pupil, teacher salary and education level, availability of teaching materials, and so on. The pupil-teacher ratio is expected to be negatively correlated with test scores because students can learn more rapidly by having more frequent interactions with teachers in smaller classes. Although certain teaching strategies can be effective even for very large classes, students are often unruly in these settings. Moreover, teachers in large classes tend to focus more on rote learning, rather than on problem-solving skills (Psacharopoulos and Woodhall [1985, p.176]).

A teacher's salary and education level would be indicators of a teacher's quality. Higher salaries attract more qualified and productive teachers who can contribute more effectively to students' achievement. Several studies show that teacher quality has a strong effect on student achievement (Behrman and Birdsall [1983] and Card and Krueger [1992]).

Total educational expenditure per pupil is expected to have a positive effect on student achievement. A major portion of total recurrent expenditure is accounted for by teachers' salaries. Other parts of educational expenditure provide students with more plentiful school resources, notably instructional materials. Fuller (1986) provides a review of studies that show a positive relationship between pupil achievement and the availability of textbooks and other instructional materials.

The relationship between school resources and pupil achievement is controversial. Some studies show that schooling inputs have only a weak or insignificant impact on achievement. In a survey of these studies, Hanushek (1986, 1995) concludes that there is no systematic relationship between student performance and commonly measured attributes of schools and teachers. Several studies have challenged this pessimistic conclusion. For example, Heynemen and Loxley (1983) show that school resources have much stronger effects on achievement in developing than in developed countries: in a sample of twenty-nine countries the proportion of explained test score variance attributable to school variables turned out to be two or three times higher in less developed countries than in developed countries. Card and Krueger (1996a, 1996b) and Altonji and Dunn (1996) argue from U.S.

data that there is a strong positive relation between school resources and student outcomes.

Hedges, Laine, and Greenwald (1994) and Kremer (1995) criticize Hanushek's methodology in that Hanushek weights equally all the studies with positive, negative, or insignificant results, and then makes a conclusion about the effects of school inputs on pupil achievement based on the fraction of the studies that show insignificant results. They argue that since most of these studies are statistically designed to give a higher probability of obtaining an insignificant result, the simple aggregation of the studies is not a correct procedure, A more accurate aggregation of the information from the available studies reveals a strong positive effect of school inputs on school quality.

Another dimension of schooling input is the intensity of operation. The length of the term indicates how intensively schools are operated but can also be a signal of how importantly school education is perceived in a society. In addition, the length of the term can be influenced by natural and weather conditions.

III. International Data on Schooling Quality

In order to estimate the education production function of equation (1), we have compiled data on school outcomes and inputs for a large number of countries. The outcome measures are the international data on test scores and the rates of grade repetition and dropping out. The input measures include indicators of school resources and intensity of education: pupil-teacher ratios, real public educational spending per student, estimated real salaries of teachers, and length of the school year (days per year and hours per day). The data on these variables are available for a broad cross section of countries. Unfortunately, we do not presently have information on the education level of teachers. We now discuss the data that we have compiled on each concept.

A. Test Scores

The main sources of test scores are the examinations in mathematics, science, and reading that have been conducted in various years for up to 58 countries by the International Association for the Evaluation of Educational Achievement (IEA) and the International Assessment of Educational Progress (IAEP). These studies cover primary or secondary students of the same age or grade group, such as age 9, age 13, and pupils in the last year of secondary education.

Since its establishment in 1959, the IEA, a non-governmental international organization headquartered in the Hague, has been carrying out international comparative studies of student achievement focusing on primary and secondary school subjects. The IEA's first international study of educational achievement in primary and secondary mathematics was conducted in 11 countries during 1963 and 1964, surveying two age groups-age 13 (U.S. 8th grade) and students in the last year of secondary education (U.S. 12th grade). Other studies in the subjects of mathematics, science, and reading include the Six-Subject Survey (in science, reading, literature, English and French as foreign languages, and civic education, with a varying number of countries, from 8 (French) to 19 (science), completed in 1972-73); the Second International Mathematics Study (20 countries, data collection in 1981); the Second International Science Study (24 countries, 1984); and the Reading Literacy Study (31 countries, 1991) (see Table 1). The Third International Mathematics and Science Study (TIMSS) is currently ongoing, covering up to 50 countries.[1] The IEA studies administered in other subjects include the Classroom Environment Study (10 countries, 1982); the Written Composition Study (13 countries, 1984-85); the Pre-Primary Project (14 countries, 1988-95); and the Computers in Education Study (20 countries, 1988-92).[2]

The International Assessment of Educational Progress (IAEP) is the only other research project of cross-national comparison of student achievement. The IAEP studies are international replications of another research program-- the National Assessment of Educational Progress (NAEP)-- which has been conducted in the United States periodically since 1969. The first IAEP project in 1988 was only experimental, involving 13-year-olds in six countries (12 educational systems). The second project, conducted in 1991, was much more extensive. The mathematics and science achievements of 9- and 13-year-old students were assessed in 20 countries (see Table 1).

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[1] The mathematics and science test scores for the 13-year-old pupils in 41 countries participating in the TIMSS are currently available. The complete report including test scores for 9-year-olds and students in the last year of secondary education is to be published by the end of 1997.

[2] See World Education Report, 1991.

An appendix, available on request, contains the data on average test scores for the students of the different age groups for the various subjects. The original test scores are reported in various formats such as number of items correct, percent correct, and scores expressed on proficiency scales (scales ranging from 0 to 1000, with a mean of 500 and a standard deviation of 100). For comparability of data, we transformed all test scores to the percent- correct form. The data were compiled from Lockheed, et al (1991), Medrich and Griffith (1992), and Department of Education (1993).

Of the 58 countries that have participated in the international mathematics, science, and reading achievement tests, the United States is the only country to take all of the tests. Most OECD countries were involved in studies more than twice. The developing countries that have participated in the studies include 7 countries from the East Asia/Pacific region, 4 from Middle East/North Africa, 7 from Sub-Saharan Africa, 5 from Latin America, 1 from South Asia, and 11 from former Centrally Planned Economies (see Appendix Table).

An important aspect of valid international comparisons of educational achievement concerns international comparability of test procedures and assessments across countries and over time. Each test uses a common assessment questionnaire that reflects the curricula of all participating countries. A potential problem with international assessments is that student performance in specific areas reflects different national emphases in school curricula (see World Education Report [1991, p.85]). A further problem involves the difficulty in obtaining representative samples of pupils. The sampling procedures adopted by IEA and

IAEP involve standard survey methodology: two- or three- stage stratified samples were drawn in which the primary sampling unit is usually the school, and schools are stratified by type, region, and size. It is, however, difficult to ensure the same level of quality control in the sampling and field execution across all participating countries. Sampling and non-sampling errors occur because of small numbers of students, non-responses in surveys, and mistakes in collecting and processing data.

B. Pupil-Teacher Ratios

For most countries, the data from *UNESCO Statistical Yearbook*, Lockheed, et al (1991), and other sources on total pupils includes those of all ages in public and private schools. (A private school is defined as " a school not operated by a public authority, whether or not it receives financial support from such authorities.") However, for a few countries, the figures refer to public schools only. Also, for some countries, the counts of pupils (and teachers) include participants in pre-primary schools.

In most cases, the counts of teachers refer to full- and part-time instructors in public and private schools. A teacher is defined as "a person directly engaged in instructing a group of pupils." Thus, supervisory and other personnel are supposed to be included only when they have regular teaching responsibilities.

In the calculation of pupil-teacher ratios, some of the underlying data errors tend to cancel. For example, if the counts of personnel refer only to public schools or add persons in pre-primary schools, then the same proportionate error tends to appear in the numerator and denominator of the ratio.

The appendix includes the data that we have compiled on pupil-teacher ratios at the primary and secondary levels for an array of countries at five-year intervals from 1960 to 1990. A summary of the information by region appears in Table 2. The Table considers groups of 23 OECD countries, 9 countries that formerly had centrally planned economies (CPE's), and 73 developing countries. The developing group is further broken down into five regions: Middle East/North Africa (10 countries), Sub-Saharan Africa (23), Latin America/ Caribbean (23), East Asia/Pacific (10), and South Asia (7). Regional averages are unweighted averages of the countries with data in each region.

At the primary level, the pupil-teacher ratio is much lower (that is, educational "quality" is much higher) in the OECD and CPE countries than in the developing countries. Moreover, the ratio has fallen dramatically over time in the OECD and CPEs; from 1960 to 1990, the value declined from 30 to 16 in the OECD and from 30 to 18 in the CPEs. For the developing countries overall, the decline is much more moderate, from 38 in 1960 to 33 in 1990. The ratio rose in South Asia (from 37 to 44) and Sub Saharan Africa (from 42 to 43).

At the secondary level, the regions are more similar in the pupil-teacher ratios. From 1960 to 1990, the OECD fell from 18 to 13, the CPEs fell from 17 to 16, and the overall group of developing countries rose from 19 to 21.

C. Real Public Educational Spending per Pupil

The standard figures on public current educational spending (from UNESCO *Statistical Yearbooks*, UNDP [1990], Lockheed, et al [1991]) comprise expenditures on public education plus subsidies for private education from all levels of government. Figures on total current educational outlays (not including capital spending) are available by level of schooling—primary, secondary, and higher.

We converted the local currency figures on educational spending into real terms—that is, PPP-adjusted 1985 international dollars—by using the GDP deflators given in the Summers-Heston version 5.6 data bank (available from the National Bureau of Economic Research). (An alternative would be to use a PPP deflator that refers specifically to education.) We then divided the real spending figures by the number of students enrolled in the corresponding level of schooling. We have also computed the ratio of real spending on education per pupil to a country's real per capita GDP. The resulting figures are included in the appendix at five-year intervals for the various countries from 1960 to 1990.

One source of error in the figures on real spending per pupil or in relation to real per capita GDP is the discrepancy in the coverage of spending and numbers of pupils. The spending figures exclude private outlays (although they include public subsidies to private schools), whereas the counts of pupils usually include all students.[3] Since private education is typically more important at the secondary level, this error is more serious for the secondary-school figures than for the primary-school figures.

Table 2 shows summary values by region for the spending figures. The figures are unweighted averages of countries with available data in each region. Hence, the number of countries included varies over time. Real spending per pupil at the primary level rose over time in the OECD; from \$546 in 1960 to \$2699 in 1990 (all expressed in 1985 dollars). For the developing countries overall, real spending per pupil at the primary level rose from \$157 in 1960 to \$282 in 1990. This rising trend applies to all regions except Sub Saharan Africa and the CPEs. From 1960 to 1990, ratios of primary spending to per capita GDP changed from .09 to .20 in the OECD and from .14 to . 10 in the developing countries. The ratio has dropped in the CPEs, from .44 in 1965 to .16 in 1990.

At the secondary level, the trend in the spending pattern is less uniform. Real educational expenditures per pupil rose in the OECD, Middle East/North Africa, and East Asia, remained roughly constant in Latin America, and fell in Sub Saharan Africa, South

[3] Good data on private educational expenditure does not exist for most countries. The available data suggest that countries differ considerably in the extent of private education: private expenditures on education (including tuition fees and purchases of books and materials) range from less than 1 percent to about 3 to 4 percent of total private consumption expenditure. The difference occurs, in part, because private schools in some countries charge tuition fees, whereas in others tuition fees are paid by government subsidies. The proportion of enrollment in private schools also varies substantially across countries. See Psacharopoulos and Woodhall (1985, pp.130-137).

Asia, and the CPEs. The ratios of secondary spending to per capita GDP fell over time in the overall group of developing countries, from .90 in 1960 to .26 in 1990. This declining trend applies to all developing regions and CPEs. In contrast, the ratio has increased in the OECD, from .13 in 1960 to .20 in 1990. Recall, however, that the spending figures at the secondary level are likely to be inaccurate because of the discrepancy in coverage between expenditures and numbers of students. In particular, a rising trend of the share of secondary students enrolled in public schools would give the erroneous impression of a fall over time in real spending per pupil.

D. Real Salaries of Primary School Teachers

We have obtained rough estimates of the average real salary of primary school teachers and the ratio of this real salary to real per capita GDP. For most countries and years, we can compute the ratio of total current real educational expenditures to the total number of teachers in primary schools. We also have information in most cases on the fraction of educational expenditures that goes to teachers' salaries (at all levels of schooling) and on the fraction of total school spending that goes to primary schools. (The UNESCO data are supplemented here by information in U.S. Department of Education [1992] and Nelson and O'Brien [1993].) The frequently missing item is the share of total spending on teachers' salaries that goes to primary school teachers. We have estimated the missing data by means of a regression of the primary school share of total salaries on the primary school share of total expenditures.[4]

The appendix contains the estimates of real salaries of primary school teachers and also reports these figures as a ratio to real per capita GDP. One source of error in these numbers—aside from the rough approximation of the total outlay for primary teachers' salaries—is that the salary figures refer only to public outlays (including subsidies to private institutions), whereas the counts of teachers include those at private schools. On this ground, the reported figures would understate the true real salary per teacher. Since this problem is especially serious at the secondary level—where a substantial fraction of teachers are employed at private schools—we have not yet estimated the salary per teacher at this level.

Table 2 summarizes the salary figures by region; from 1960 to 1990, the real average salary per primary school teacher increased from $10428 to $26820 in the OECD and from $4869 to $7179 in developing countries. The rising trend applies to all developing regions, especially to East Asia, where the value rose from $3624 to $10665. In contrast, the figures for the CPEs have fallen markedly from $14462 in 1965 to $4771 in 1990. The ratios of estimated real salaries of primary school teachers to per capita GDP have typically declined

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[4]From the annual observations that are available, a regression of the share of primary school salaries in total teachers' salaries (denoted SHSAL) on the fraction of primary in total educational outlays (denoted SHEXP) yields

$$\underset{}{SHSAL} = \underset{(0.01)}{0.07} + \underset{(0.03)}{1.07}{*}SHEXP, \quad R^2 = 0.70, \text{ number of observations} = 561,$$

where the numbers in parentheses are standard errors.

over time; from 1965 to 1990, the value dropped from 2.5 to 2.2 in the OECD, from 4.9 to 3.6 in the overall group of developing countries, and from 7.4 to 1.7 in the CPEs. These ratios tend to be higher in the developing countries, especially in Sub Saharan Africa (5.1 in 1990) than in the OECD.

E. Repetition and Dropout Rates

School repeaters are defined as "pupils who are enrolled in the same grade as the previous year." We measure the repetition rate as the percentage of repeaters in the total number of students enrolled at a given level. Our conjecture is that a higher repetition rate will indicate a lower quality of schooling or a lower raw material of students. The repetition rate would, however, also be influenced by variations in the promotion standards of schools.[5]

The necessary data on repeaters are available for primary schools from 1965 to 1990 and for secondary schools from 1970 to 1990. (Figures from UNESCO were supplemented from data in Lockheed, et al [1991].) The full set of these figures appears in the appendix.

Table 2 provides summary information by region on repetition rates. The rates at the primary level are much higher in the developing countries overall (12.5 in 1990) than in the

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[5] A number of countries, including Japan, Korea, and Malaysia, adopt a policy of automatic promotion. Most countries have regulations on promotion but also some kind of restriction on grade repetition, such as prohibitions of repetition in certain grades or limitations of the number of repetitions in a given cycle.

OECD (3.3 in 1990) and in the CPEs (3.1 in 1990). The rates are highest in Sub Saharan Africa and are exceptionally small in East Asia. In most of the developing regions, the rate has fallen over time. At the secondary level, the repetition rates are similar overall for the OECD (12.0 in 1990) and the developing countries (11.5 in 1990); the CPEs and the East Asian area again show notably low rates. The rate has increased over time in Sub Saharan Africa and the OECD, but has fallen in South Asia.

We have also compiled data on the primary school dropout rate. This rate is defined as the percentage of children who start primary school but do not eventually reach the final grade of primary school. The estimate of dropouts is constructed by the Reconstructed Cohort Method, which uses data on enrollments and repeaters for two consecutive years. The data are available from 1970 to 1990. The information comes from Lockheed, et al (1991) and UNESCO (1993). The dropout rates by region are summarized in Table 2; the rates have been much higher in the developing countries overall that in the OECD and the CPEs. The East Asian area shows notably low dropout rates.

F. Length of the School Year

We have compiled information on the length of the school year in terms of days and hours at the primary level. The number of school days is computed as the number of school days per week multiplied by the number of school weeks per year. The number of hours is the number of school hours per week multiplied by the number of school weeks per year.

The data on school days are apparently available for a broad cross section of countries only for 1990; the information comes from UNESCO's 1991 *Special Survey of Primary Education*.

The figures on the number of school hours tend to be unreliable because of the large variation in school hours per day within a country depending on region and grade level. Therefore, the number of school days per year may be more informative as a measure of the length of the school year.

Table 2 provides summary information by region on school length. The numbers of school days and school hours are similar in the OECD (195 days) and the developing countries overall (197). The figures are, however, low in the CPEs (180) and notably high in the East Asian area (208).

IV. Regression Results for Test Scores

We estimate the educational production function of equation (1) based on the panel data set of the output and input measures of schooling that we have compiled. The family factors considered are the log of real per capita GDP, a proxy for parent's income, and average primary schooling years of adults aged 25 and over, a proxy for education of parents.[6] The measures of school resources are the pupil-teacher ratio in primary school, the

[6] We have also added average years of secondary schooling as a measure of parents' education. The secondary education variable turns out to be statistically insignificant, though with a positive coefficient, in the regressions for test scores.

log of real public educational spending per student in primary education, the log of real salary per primary school teacher, and the length of the primary school year. The measures of school inputs were described in the previous section. For the family factors, real per capita GDP is from the Summers-Heston version 5.6 data bank, and the schooling data are from Barro and Lee (1996).[7]

The test scores are available disaggregated by subject: mathematics, science, and reading; by the age group of students; and by the year of the test. Each test has a varying number of observations, depending on the number of countries that participated in the project. In the estimation, we use only test scores for the 10- and 14-year old students.[8] We do not use the test scores for the students in the final year of secondary education, because some measures of secondary school inputs, such as teachers' salary and length of the school year, are not available at this level. Since the students aged 9 to 14 typically attend primary school, the test scores for students of these ages would depend on primary school inputs.[9]

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[7] The Summers-Heston data set is available from the NBER web site (www.nber.harvard.edu), and the Barro-Lee schooling data are available from the World Bank web site (www.worldbank.org/html/prdmg/grthweb/growth_t.htm).

[8] The regressions do not include mathematics and science test scores in 1993-98 for the 13 years-old students from the Third International Mathematics and Science Study (TIMSS). We have just obtained the data but do not have the input measures of 1995 to match them with. When the system of equations described below was expanded to include additional equations relating these test scores to the input measures of 1990, there were no significant changes in the regression results.

[9] An alternative would be to relate the school inputs to the change in test scores between age groups and thereby assess the value added from primary education. Unfortunately, the sample size becomes too small in this case.

Because the input measures are available for five year intervals from 1960 to 1990, we matched the input measures with test scores in the nearest year for which the score is available. For instance, we relate the test scores of 1964 to the input measures of 1965, the test scores of 1982 to the input measures of 1980, and so on.[10]

The education production function that relates test scores to inputs in a broad panel of countries can be specified as follows:

$$Q_{ijt} = \alpha_{ijt} + \beta_1 * F_t + \beta_2 * R_t + \epsilon_{ijt} \tag{2}$$

where Q_{ijt} denotes test scores of subject i (mathematics, science, and reading) for students of age group j (10- and 14-year-olds) in year t (1964, 1970-72, 1982-83, 1984, and 1990-91); F_t denotes family factors (income and schooling) in year t; R_t denotes school resources (pupil-teacher ratio, average teacher salary, educational expenditure per pupil, school length) in year t; and ϵ_{ijt} denotes unmeasured factors influencing school quality. The panel consists of a system of 13 equations. The system is estimated by the seemingly-unrelated-regression (SUR) technique. This procedure allows for different error variances in each equation and for correlation of these errors across the equations. We allow for different constant terms in each equation but assume that the slope coefficients are the same for each input measure. The

[10] Family and school inputs may influence test scores with a lag. When we allowed a five-year lag of input variables in the regressions, the empirical results did not change in qualitative terms.

regressions apply to a total of 214 observations. Each equation has a varying number of observations depending to the availability of test-score data.

Column 1 of Table 3 presents the results of the basic regression. The results show the strong effects of family inputs on student achievement. The positive coefficient on the log of per capita GDP (3.41, t = 3.20) confirms that school children from higher income countries tend to achieve higher test scores, holding fixed other factors that influence student achievement. This result suggests that parents' income has a strong positive effect on children's academic performance. The estimated coefficient implies that a one-standard-deviation increase in the log of per capita GDP (by 0.9 in 1990) raises test scores by 3.1 percentage points.

The average educational level, entered in the form of average years of primary school attainment for adults aged 25 and above, has a significantly positive effect on test scores. The estimated coefficient on the schooling variable (1.35, t= 4.90) indicates that a one-standard-deviation increase in average years of primary schooling (by 1.7 years in 1990) is estimated to raise test scores by 2.3 percentage points. Hence, this result suggests that parents' education has an important positive effect on the children's test scores.[11]

The regression also includes three measures of school resources—pupil-teacher ratio, the log of public educational expenditure per pupil, and the log of the average salary of

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[11] The average years of schooling variable is interpreted as education of parents, but it can also reflect education of teachers. Thus, the regression result may indicate that education of teachers, as well as parents, is important for children's achievement.

primary school teachers. The pupil-teacher ratio has a negative relation with test scores, confirming that smaller classes are better for pupil achievement. The estimated coefficient (-0.22, t = 2.54) implies that a one-standard-deviation decrease in the pupil-teacher ratio (by 12.3 in 1990) raises test scores by 2.7 percentage points.

The log of the average salary of primary school teachers has a positive and significant relation with test scores. However, the log of total educational spending per student is insignificant (with a negative sign). Since the three school-resource variables—school spending per pupil, average salary of teachers, and the pupil-teacher ratio—are highly correlated, it is difficult to separate their effects.[12] However, a chi-square test for the three variables together has a p-value of 0.00. Therefore, there is a clear overall indication that more school resources produce better student outcomes.

The regression in column 1 of Table 3 also includes the length of the school term as a measure of the intensity of education. This variable turns out to be insignificant.

Column 2 of Table 3 includes a regional dummy for the East Asian countries.[13]

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[12] Because the regression includes four school variables-- teacher-pupil ratio, teacher salary, education spending, and school length--, the effect of each variable on test scores may reflect shifts of expenditure among categories, rather than the direct effect of more spending in one category. For example, the estimated coefficient on the teacher-pupil ratio indicates the effect on student achievement of smaller class sizes when total educational spending is held fixed. Regressions without the total education spending variable reveal slightly smaller effects of the teacher-pupil ratio and teachers' salary on test scores, but maintain all the same qualitative results.

[13] The East Asian dummy indicates East and Southeast Asia geographical region. The seven countries in our sample include Hong Kong, Indonesia, Singapore, Korea, the Philippines, Taiwan, and Thailand.

This dummy variable has a large and significant coefficient (3.6, t = 3.6). Therefore, a major component of East Asia's academic performance is left unexplained by the family and school inputs that were included in the regressions. Also, the log of teacher salary is no longer significant in column 2, but the pupil-teacher ratio remains negative and significant.

The significance of the East Asian dummy may reflect the existence of an "Asian value," which is broadly defined by the cultural and religious features unique to the East Asian countries (see Stevenson [1992, 1993] and *Economist* [1996]). In East Asia, parents tend to provide strong support for children's education. Children are often sent to cramming schools in the evening to supplement their regular classes. (In this sense, the reported figures on educational spending and school length are an underestimate of the true values.) Also, in the Confucian tradition, teachers in East Asia receive considerably more respect and prestige than do those in other societies.

The regressions in Table 3 restrict the slope coefficients for each explanatory variable to be the same in each equation. That is, the effect of a variable such as per capita GDP is the same regardless of the subject area and the age group of students who take the test. We consider now whether these coefficients vary across age groups and subjects.

Table 4 contains a variant of the system shown in column 1 of Table 3. The system in Table 4 consists of equations that allow for different slope coefficients for the test scores of the two student age groups. (In the regressions in Table 3, only the constant terms differed across the equations.)

The result in Table 4 is that the estimated coefficients for the 10-year-old students are not very different from those for the 14-year-olds. A joint test of equality for all six pairs of estimated slope coefficients for the students of the two age groups is accepted by a Wald test with a p-value of 0.6. Individual tests for the hypothesis of equality for the estimated coefficients of each independent variable are also accepted at usual critical values. The restrictions are basically similar if the East Asian dummy is included, as in column 2 of Table 3. In that case, the p-value for the overall test of coefficient equality across the two age groups is 0.4.

Table 5 carries out the analogous procedure across the three subject areas, mathematics, science, and reading. The result is that the slope coefficients do not differ much between mathematics and science but vary between reading and the other two subjects. A joint test of equality for all six pairs of estimated coefficients for mathematics and science tests is accepted by a Wald test with a p-value of 0.6 (see column 4 of the table). The individual tests for the hypothesis of equality for the estimated coefficients of each independent variable are accepted at p-values between 0.3 and 0.7. These results are similar if the East Asian dummy is included in the equations.

In contrast, the hypothesis of equality for all six pairs of estimated coefficients between mathematics and reading tests is rejected by a Wald test with a p-value of 0.00. However, for the individual independent variables, the hypothesis of equality for the estimated coefficients is rejected at the 0.10 level only for adult primary education and school length (see column 5 of Table 5). In particular, the estimated coefficient of the pupil-teacher ratio is negative and of similar magnitude for all three subjects. These results are again similar if the East Asian dummy is included in the equations. One new finding here is that the East Asian dummy is significantly stronger for mathematics and science than for reading.

The biggest surprise from the distinction by test subject involves the effects of school length. The length of the school term is significantly positive for mathematics and science scores but significantly negative for reading. Also notable is that the GDP variable is insignificant for mathematics and science test scores but significantly positive for reading.

The finding that the effects of some inputs on test scores differ by subject area may indicate that some cognitive skills can be more actively stimulated by some inputs. For instance, family income might have a positive effect on children's reading ability because more affluent parents can provide more reading materials for their children. (On the other hand, parents' education seems to be more important for mathematics and science than for reading.) The complement of the finding on family income is that the length of school term shows up as more important for mathematics and science than for reading. However, the negative association between school length and reading scores is puzzling. This puzzle was also noted by Elley (1992, p. 40).

V. Dropout and Repetition Rates

Table 6 shows results for the two other indicators of school outcomes: the repetition and dropout rates.[14] The forms of these regressions parallel those for test scores in Table 3. Columns 1 and 3 of Table 6 show that the repetition and dropout rates are each significantly negatively related to the two family variables, the log of per capita GDP and the primary education of adults.[15] These results parallel those for test scores; that is, richer and better educated adults appear to generate children who perform better on all three measures of school performance.

With respect to school inputs, the pupil-teacher ratio is significantly positive for the repetition and dropout rates in columns 1 and 3 of Table 6. These results again parallel those for test scores; a lower ratio of pupils to teachers is estimated to improve all three indicators of educational outcomes. Two other input measures—the log of average teacher salary and the log of educational spending per pupil—are not significantly related to the repetition and dropout rates. However, the estimated coefficient of the log of average teacher salary is negative and marginally significant for the school dropout rate in column 3 of Table 6. The results for test scores are basically similar, with a weak indication that higher teacher salaries are associated with better performance.

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[14] The regressions are based on the complete data set of primary repetition and dropout rates at five-year intervals from 1970 to 1990. If the number for the five-year value was missing, then we used the observed value for the nearest year; for example, we would use a value for 1980 to represent 1975. For a few countries, we interpolated to fill in missing values.

[15] Secondary schooling variable is insignificant in the regressions when included as an additional explanatory variable.

The length of the school year is significantly negative for the repetition rate in column 1 of Table 6 and is negative but not significant for the dropout rate in column 3. These results are analogous to those for test scores in mathematics and science in Table 5. However, the overall association between school length and test scores in Table 3 is essentially nil. (Recall that the relation with reading scores had the puzzling negative sign in Table 5.)

Finally, the East Asian dummy variable is significantly negative for the repetition and dropout rates in columns 2 and 4 of Table 6. These findings parallel those for test scores in column 2 of Table 3. That is, the East Asian region does better on all three measures of school performance, even after holding constant the family variables and the measures of school inputs.

Overall, the three indicators of school performance—international test scores, repetition rates, and dropout rates—yield a similar picture in regard to the roles of family factors and school inputs. The general pattern is that family influences (in the sense of richer and better educated parents) and school inputs (especially smaller class sizes but probably also higher teacher salaries and greater school length) enhance educational outcomes.

VI. Summary and Conclusion

This paper investigated the effects on school outcomes— measured by internationally comparable test scores, repetition rates, and dropout rates— from family characteristics and school resources. The regressions indicate the importance of family background, as measured by the income and education of parents. More school resources are also positively related to student performance, with the strongest results applying to pupil-teacher ratios. Weaker, but likely positive, effects also emerge for average teacher salary and the length of the school term. Our findings are, therefore, consistent with a view that inputs from schools, families, and communities are important in improving school quality.

Some interesting differences emerge across subject areas in the relation between test scores and the explanatory variables. One finding is that per capita GDP is insignificantly related to the mathematics and science test scores but strongly positively related to reading scores. Another result is that the length of the school term is positively related to mathematics and science scores but negatively related to reading performance.

This study of cross-country data shows that differences in schooling quality across countries are substantial and can be explained in part by a set of quantifiable explanatory variables. However, we do not fully explain why countries in the East Asian region obtained better educational outcomes than other developing countries. We plan to investigate further this question in subsequent research.

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Table 1.
Major international Tests for the Subjects of Mathematics, Science, and Reading

Years of Data Collection	Sponsor	Subjects	Number of Countries	Ages of Pupils
1964	IEA	Mathematics	13	13, Final Sec.*
1970-72	IEA	Science	19	10, 14, Final Sec.
		Reading Comprehension	15	10, 14, Final Sec.
1982-83	IEA	Mathematics	20	13, Final Sec.
1984	IEA	Science	24	10,14, Final Sec.
1988	IAEP	Mathematics	6	13
		Science	6	13
1991	IEA	Reading Literacy	31	9, 14
1990-91	IAEP	Mathematics	20	9,13
		Science	20	9,13
1993-98 (not complete)	IEA	Mathematics	40-50	9,13, Final Sec.
		Science	40-50	9,13, Final Sec.

*Final Sec. denotes the final year of secondary education, differing among countries.

Note: IEA stands for International Association for the Evaluation of Educational Achievement, and IAEP stands for International Assessment of Educational Progress. The countries participating in the test may not be in the sample for all the age groups.

Table 2, Part A
Trends of Schooling Quality by Region

Region	Year	Primary teacher pupil ratio	Second. teacher pupil ratio	Primary spending per pupil	Ratio to per capita GDP	Second. spending per pupil	Ratio to per capita GDP
All Developing Countries	60	38	19	157	0.14	687	0.90
	65	38	20	195	0.14	726	0.76
	70	37	20	229	0.14	710	0.67
	75	36	22	243	0.13	615	0.46
	80	34	22	283	0.12	669	0.41
	85	32	21	365	0.12	687	0.31
	90	33	21	282	0.10	590	0.26
Middle East/ North Africa	60	35	20	204	0.16	567	0.51
	65	34	21	274	0.14	687	0.39
	70	31	20	307	0.14	738	0.55
	75	29	19	339	0.12	826	0.35
	80	27	18	445	0.14	1164	0.53
	85	26	17	814	0.13	1122	0.22
	90	24	16	446	0.11	1010	0.25
Sub-Saharan Africa	60	42	19	154	0.22	1282	2.19
	65	44	19	133	0.19	939	1.47
	70	43	20	141	0.18	872	1.28
	75	45	25	147	0.17	695	0.90
	80	42	26	153	0.16	593	0.68
	85	40	25	151	0.14	605	0.58
	90	43	24	123	0.10	445	0.39
Latin America /Caribbean	60	37	17	174	0.09	435	0.24
	65	36	19	223	0.10	482	0.21
	70	36	19	247	0.09	580	0.21
	75	32	20	224	0.08	429	0.14
	80	31	21	308	0.09	479	0.13
	85	29	20	343	0.10	499	0.14
	90	28	19	272	0.09	458	0.13
East Asia/ Pacific	60	35	24	107	0.08	277	0.20
	65	33	24	153	0.09	570	0.36
	70	32	22	176	0.09	385	0.22
	75	32	23	280	0.10	531	0.21
	80	29	22	352	0.08	521	0.12
	85	27	23	504	0.10	731	0.13
	90	26	21	494	0.11	530	0.16

Table 2, Part A, continued

Region	Year	Primary teacher pupil ratio	Second. teacher pupil ratio	Primary spending per pupil	Ratio to per capita GDP	Second. spending per pupil	Ratio to per capita GDP
South Asia	60	37	23	70	0.10	215	0.36
	65	42	22	65	0.08	208	0.31
	70	38	24	89	0.09	180	0.28
	75	41	22	96	0.10	126	0.16
	80	43	24	99	0.08	133	0.14
	85	41	21	132	0.10	172	0.17
	90	44	23	154	0.09	171	0.12
O E C D	60	30	18	546	0.09	757	0.13
	65	27	17	1010	0.13	1332	0.18
	70	25	17	1192	0.13	1564	0.18
	75	22	17	1628	0.17	1842	0.20
	80	19	16	2146	0.19	2187	0.20
	85	18	14	2374	0.19	2387	0.20
	90	16	13	2699	0.20	2598	0.20
Centrally Planned Economies	60	30	17	--	--	--	--
	65	25	17	843	0.44	2087	1.10
	70	22	15	949	0.33	1590	0.58
	75	20	14	1005	0.26	1163	0.32
	80	20	16	643	0.15	1259	0.34
	85	19	16	564	0.12	1016	0.23
	90	18	16	637	0.16	1438	0.32

Note: The values in the table are the unweighted averages of the observations of the countries for each region.

Table 2, Part B
Trends of Schooling Quality by Region

Region	Year	Primary teacher salary	Ratio to per capita GDP	Primary repeater rate	Second. repeater rate	Primary drop-out rate	School days	School hours
All Developing Countries	60	4869	4.5	--	--	--	--	--
	65	5990	4.9	17	--	--	--	--
	70	6986	4.5	14	10	40	--	--
	75	6969	4.3	12	9	34	--	--
	80	6823	3.6	13	11	33	--	--
	85	7948	3.4	12	12	30	--	--
	90	7179	3.6	12	12	29	197	977
Middle East/ North Africa	60	6763	5.7	--	--	--	--	--
	65	8729	5.2	23	--	--	--	--
	70	8798	4.7	13	13	32	--	--
	75	9035	4.0	12	11	20	--	--
	80	9174	3.5	12	11	30	--	--
	85	14434	2.9	10	12	19	--	--
	90	9809	3.1	9	12	13	201	944
Sub-Saharan Africa	60	4640	6.7	--	--	--	--	--
	65	4601	6.8	22	--	--	--	--
	70	5327	6.7	17	11	47	--	--
	75	5472	6.7	17	11	35	--	--
	80	4867	5.6	17	15	33	--	--
	85	4399	5.1	19	17	38	--	--
	90	5164	5.1	20	17	39	198	1026
Latin America /Caribbean	60	5147	2.6	--	--	--	--	--
	65	6761	2.9	16	--	--	--	--
	70	8172	2.9	15	8	46	--	--
	75	6597	2.4	11	8	40	--	--
	80	7192	2.1	12	8	41	--	--
	85	7534	2.4	11	9	43	--	--
	90	7487	2.6	10	8	36	195	952
East Asia/ Pacific	60	3624	2.9	--	--	--	--	--
	65	5026	3.2	1	--	--	--	--
	70	5502	2.7	0	3	6	--	--
	75	7883	3.0	5	5	23	--	--
	80	9737	2.4	4	7	10	--	--
	85	13618	2.5	3	4	9	--	--
	90	10665	2.9	4	1	13	208	1097

Table 2, Part B, continued

Region	Year	Primary teacher salary	Ratio to per capita GDP	Primary repeater rate	Second. repeater rate	Primary drop-out rate	School days	School hours
South Asia	60	2521	4.1	--	--	--	--	--
	65	2539	3.6	20	--	--	--	--
	70	3313	3.6	21	23	--	--	--
	75	3457	3.6	21	18	79	--	--
	80	2723	2.0	14	11	80	--	--
	85	4402	3.2	10	7	14	--	--
	90	3507	2.5	9	9	44	201	981
O E C D	60	10428	1.9	--	--	--	--	--
	65	18256	2.5	5	--	--	--	--
	70	19887	2.3	5	8	7	--	--
	75	25362	2.8	5	10	2	--	--
	80	24765	2.4	4	11	2	--	--
	85	27783	2.5	4	13	7	--	--
	90	26820	2.2	3	12	3	195	974
Centrally Planned Economies	60	--	--	--	--	--	--	--
	65	14462	7.4	8	--	--	--	--
	70	13888	4.6	5	5	4	--	--
	75	13486	3.3	3	2	5	--	--
	80	9194	2.3	2	2	2	--	--
	85	7899	1.8	2	1	8	--	--
	90	4771	1.7	3	2	9	180	845

Note: The values in the table are the unweighted averages of the observations of the countries for each region.

Table 3. Regressions for Test Scores

Independent variable	(1)	(2)
log(GDP per capita)	3.41 (3.20)	3.43 (3.43)
Primary Education of Adults	1.35 (4.90)	1.18 (4.56)
Pupil-Teacher Ratio	-0.22 (2.54)	-0.21 (2.53)
log(Average teacher salary)	2.88 (2.09)	2.19 (1.66)
log(Educ. expend. per pupil)	-1.34 (1.13)	-0.30 (0.26)
Length of School Days	0.003 (0.14)	-0.02 (0.93)
Dummy for East Asia		3.61 (3.57)

Exam	R^2 (number of observations)	
Math, 1964, age 14	-0.16 (11)	-0.24 (11)
Math, 1982, age 14	0.10 (15)	0.11 (15)
Math, 1990, age 10	-0.57 (12)	-0.29 (12)
Math, 1990, age 14	0.24 (18)	0.27 (18)
Science, 1970, age 10	0.54 (14)	0.53 (14)
Science, 1970, age 14	0.50 (16)	0.51 (16)
Science, 1984, age 10	0.18 (15)	0.14 (15)
Science, 1984, age 14	0.34 (17)	0.27 (17)
Science, 1990, age 10	-0.19 (12)	0.15 (12)
Science, 1990, age 14	0.11 (17)	0.21 (17)
Reading, 1970, age 10	0.74 (12)	0.73 (12)
Reading, 1990, age 14	0.66 (29)	0.73 (29)
Reading, 1990, age 10	0.47 (26)	0.54 (26)

Notes: The system has 13 equations, where the dependent variables are the scores on internationally comparable tests in mathematics, science, and reading in various years for the students aged 10 or 14. Each equation has a different constant term (not shown). Absolute values of t-statistics are reported in parentheses. The R^2 values and number of observations apply to each equation individually.

Estimation is by the SUR technique. The estimation allows for different error variances in each equation and for correlation of these errors across equations.

Table 4. Regressions for Test Scores by Age Groups of Students

	(1) Age 10	(2) Age 14	(3) p-value (1)=(2)
Independent variable			
log(GDP per capita)	4.23 (2.92)	3.03 (2.60)	0.40
Primary Education of Adults	1.35 (4.13)	1.48 (4.91)	0.67
Pupil-Teacher Ratio	-0.25 (2.36)	-0.20 (2.15)	0.61
log(Average teacher salary)	3.54 (2.13)	1.92 (1.30)	0.61
log(Educ. expend. per pupil)	-2.02 (1.43)	-0.69 (0.54)	0.30
Length of School Days	0.004 (0.16)	0.01 (0.39)	0.81
			0.60*

Exam (subject, year)	R^2 (number of observations)	
Math, 1964		-0.13 (11)
Math, 1982		0.09 (15)
Math, 1990	-0.67 (12)	0.27 (18)
Science, 1970	0.54 (14)	0.54 (16)
Science, 1984	0.14 (15)	0.35 (17)
Science, 1990	-0.24 (12)	0.17 (17)
Reading, 1970	0.75 (12)	
Reading, 1990	0.43 (26)	0.65 (29)

Notes: The system is a variant of the one shown in column 1 of Table 3. The system has 13 equations, but allows for different coefficients for the independent variables in the equations for each age group. In Table 3, only the constant terms differed across equations. Absolute values of t-statistics are reported in parentheses. The R^2 values and number of observations apply to each equation individually.

Estimation is by the SUR technique. The p-values in column 3 refer to Wald tests of equality for the coefficients of the two-groups. The p-value in the last line, noted by *, is for a Wald test of the hypothesis that all the coefficients are equal for columns (1) and (2).

Table 5. Regressions for Test Scores by Subjects

	Mathematics (1)	Science (2)	Reading (3)	p-value (4)	(5)	(6)
Independent variable						
log(GDP per capita)	1.78 (0.58)	2.94 (1.41)	3.63 (3.22)	0.66	0.57	0.85
Primary Education of Adults	2.22 (3.31)	1.78 (4.30)	0.87 (2.82)	0.41	0.06	0.13
Pupil-Teacher Ratio	-0.26 (1.47)	-0.11 (1.03)	-0.22 (2.02)	0.32	0.83	0.47
log(Average teacher salary)	1.00 (0.31)	-1.27 (0.63)	3.96 (2.48)	0.43	0.41	0.08
log(Educ. expend. per pupil)	-0.29 (0.10)	2.48 (1.31)	-1.80 (1.35)	0.28	0.65	0.09
Length of school days	0.14 (2.86)	0.11 (3.49)	-0.06 (2.24)	0.43	0.00	0.00
				0.65*	0.00*	0.00*

Exam (year, age group)	R^2 (number of observations)		
1964, age 14	0.06 (11)		
1970, age 10		0.63 (14)	0.71 (12)
1970, age 14		0.61 (16)	
1982, age 14	-0.03 (15)		
1984, age 10		0.27 (15)	
1984, age 14		0.36 (17)	
1990, age 10	-0.25 (12)	-0.07 (12)	0.71 (26)
1990, age 14	0.43 (18)	0.28 (17)	0.61 (29)

Notes: The system is a variant of the one shown in column of Table 3. The system has 13 equations, but allows for different slope coefficients for each of the three subject areas. Absolute values of t-statistics are reported in parentheses. The R^2 values and number of observations apply to each equation individually.

Estimation is by the SUR technique. The p-values in column 4 refer to Wald tests of equality for the coefficients of the mathematics and science tests. The p-values in column 5 refer to Wald tests of equality for the coefficients of the mathematics and reading tests. The p-values in column 6 refer to Wald tests of equality for the coefficients of all three subjects- mathematics, science, and reading. The p-values in the last line, noted by *, are for Wald Tests of the hypothesis that all the coefficients are equal.

Table 6. Regressions for School Repetition and Dropout Rates

	(1)	(2)	(3)	(4)
Independent variable				
log(GDP per capita)	-2.18 (2.52)	-2.17 (2.56)	-4.90 (2.27)	-5.13 (2.28)
Primary Education of Adults	-1.11 (3.63)	-0.96 (3.15)	-2.29 (2.76)	-2.40 (2.89)
Pupil-Teacher Ratio	0.16 (3.58)	0.15 (3.38)	0.34 (2.66)	0.30 (2.30)
log(Average teacher salary)	-0.02 (0.01)	-0.38 (0.37)	-4.29 (1.55)	-3.76 (1.36)
log(Educ. expend. per pupil)	0.15 (0.14)	-0.35 (0.32)	-0.03 (0.01)	-0.54 (0.18)
Length of School Days	-0.08 (3.50)	-0.07 (2.93)	-0.08 (1.13)	-0.06 (0.83)
East Asia		-4.39 (3.21)		-8.07 (1.93)
Year	R^2 (number of observations)			
1970	0.41 (64)	0.48 (64)	0.46 (71)	0.49 (71)
1975	0.32 (68)	0.36 (68)	0.45 (72)	0.44 (72)
1980	0.43 (74)	0.46 (74)	0.48 (73)	0.49 (73)
1985	0.45 (66)	0.49 (66)	0.49 (68)	0.50 (68)
1990	0.53 (65)	0.55 (65)	0.42 (62)	0.43 (62)

Notes: The systems have five equations corresponding to 1970, 1975, 1980, 1985 and 1990. The dependent variable in columns 1 and 2 is the primary school repetition rate. In columns 3 and 4, the dependent variable is the school dropout rate. Each equation has a different constant term (not shown). Absolute values of t-statistics are reported in parentheses. The R^2 values and number of observations apply to each equation individually.

Estimation is by the SUR technique. The estimation allows for different error variances in each equation and for correlation of these errors across equations.