WHAT INVESTMENTS RAISE SCHOOL OUTCOME: IMPROVING SCHOOL QUALITY OR INCREASING SCHOOL QUANTITY?

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April 1997

Abstract

With an international comparison of 142 countries for the period of 1960-1990, the regression analysis in this study reveals the different impacts of school quantity (represented by the length of compulsory schooling) and school quality (per-student expenditures and student-teacher ratio) on school output (literacy rate and repetition rate). Although inputs from both school quantity and quality are significantly influencing the school output in general, the magnitudes of such impacts are various at the different stages of schooling as well as the different time period. Comparing the countries with primary compulsory schooling and the countries with secondary compulsory schooling, school quantity plays a more important role than school quality in determining school output at the primary stage. The contribution of improving in school quality to school output tends to be increasingly significant when the length of compulsory schooling has reached a sufficiently high level.

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Introduction

Since the early 1980s, understanding the educational quality issues in the context of economic development has become an active concern for several reasons. First, tightened budget constraints have forced governments in many developing countries to shift the emphasis away from further increase in public spending on education to search for greater effectiveness of spending. Reallocation of expenditure and improvement of educational quality are the ways of improving efficiency (Throsby and Gannicott 1990, OECD 1992). Especially, the efficiency of transmitting technical and vocational skills depends on the quality of basic education (Heyneman and White 1986).

Second, many governments have become aware that the rapid expansion of enrollments during the 1960s and 1970s was achieved only at the expense of a lowered educational standard. Poor countries under tight budgetary constraints faced an inevitable trade-off between quantity and quality objectives in allocating educational resources (Throsby and Gannicott 1990, Mingat and Tan 1988). Repetition, drop-out rates, and functional illiteracy remain high for many primary school graduates in developing countries which reflect the waste of educational investment (the United Nations 1990, Verspoor 1989, Fuller 1986, Passow 1976, Walker 1976).

Third, some studies have indicated that failure to consider school quality in estimating the relationship of education and economic growth causes biases in explaining the real situation (Behrman and Birdsall 1983). For example, some researchers have found that increasing enrollments or school quantity did not have consistent positive impact on economic development (Walters 1981). Such inconsistent results of education and economic growth arise partly from the translating considerations of the school quantity into implications about the investments in improved school quality (Hanushek, 1996). Failing to improve school quality when increasing school quantity leads to a further waste of resources (Fuller and Heyneman 1989, Chapman and Carrier 1990). Therefore, in order to

maximize efficiency of educational investment, educational development should keep pace with socio-economic development and maintain a balance between increasing quantity and improving quality. The objective of this research is to empirically examine and compare the effects of the investments on both school quality and the school quantity have brought to school outcome by using an international data set. Here the school quantity is represented by the length of compulsory schooling because as the core of modern education, compulsory schooling policy provides the main foundation of formal education for virtually all children, and thus is seen as the arena for the performance of a nation's fundamental educational policy. Although some research has examined the impact of educational quality on school output and the future earnings of students, the existing study of the school quality issue has been restricted to the case of an individual country, a cross-country comparison of school quality and quantity deserves further attention.

Measurement of and Empirical Studies on School Quality

The term "school quality" refers to the input quality of education, which is often associated with student's level of academic performance (that is, quality of outcome). Both input quantity and input quality of schooling determine the quality of educational outcome. Some important input quality indicators include material inputs, teacher quality, and teaching practices (Heyneman and Loxley 1983, Stuart 1983, Fuller 1986, Verspoor 1989).

The concentration of material resources per student indicates a fundamental shift in policy from the number of children being served to the quality of instruction given to each student. Summarized by Fuller (1986,1990), the material inputs include expenditures per student, class size represented by student-teacher ratio, instructional materials per student, and the availability and size of libraries, laboratories, and other instructional equipment. As for the index of expenditures per student, if this spending is highly related to instructional materials and teaching, it relates to higher student achievement (Fuller 1990, Throsby and Gannicott 1990). Yet, substantial reductions in class size are also necessary to raise achievement. For instance, In her comments on educational expenditures and school

achievement, Kazal-Thresher (1993) introduced Ronald Ferguson's work. By using U.S. data, Ferguson found that reducing the number of students per teacher improved students' reading test scores when the ratio exceeded 18 to 1. In small classes, learning can be significantly enhanced through individual attention to the needs of students. In very large classes, discipline and monitoring of progress breaks down to the detriment of the learning process. Fuller and Heyneman (1989) also found, based on survey data from 16 developing countries and 13 developed countries, for developing countries, the quality of material inputs (number of textbooks and desks available, the length of the instructional program, and the educational level of teachers) had a strong effect on student achievement and eventual economic gains.

Besides material input allocation, teacher quality and teaching practices are also crucial to influencing student achievement (Fuller 1990, Throsby and Gannicott 1990, Verspoor 1989, Ferguson 1991). Teacher quality includes total years of teacher's schooling, degrees held, years of teacher training, length of teaching experience, verbal proficiency, salary level, social class background, and school's percent of full-time teachers. Teaching practices include length of instructional program, homework frequency, teacher's time spent on class preparation and curriculum reform. In addition, other variables such as school management, decentralization of the school system, and students' family background also have potential impact on student achievement. However, the criteria of measuring teacher quality, teaching practice and other variables are so different from one country to another, that it is difficult to conduct international comparisons by examining these quality indicators. Therefore, the expenditures per student and student-teacher ratio are frequently examined as proxies of school quality.

In terms of investigating the returns to improving education quality, Behrman and Birdsall (1983) compared the rates of private and social returns to both school expansion and school quality improvement for Brazil. In another study Card and Krueger (1992) estimated the effects of school quality on the rate of return to education for men in the United States.

Behrman and Birdsall established a theoretical model which incorporates both educational quality and quantity into an earning function. They found that the exclusion of the quality variable in the model causes biases in the estimated returns to years of schooling. Further, they explored the implications of this theoretical model for the empirical case of Brazil with data set a random sample of 6,171 males at ages 15-35 based on the 1970 Brazilian census. By comparing the returns to years of schooling (a measure of school quantity) and the average level of schooling of teachers (a measure of school quality), the regression results indicated that the omission of the school quality factor led to an upward bias in the estimated returns to years of schooling. This finding means that without considering school quality, the role of years of schooling was overemphasized. As a result, "deepening" schooling by increasing quality has a higher rate of social return than "broadening" schooling by simply increasing quantity.

Using a similar framework, Card and Krueger (1992) presented an extensive analysis of the relationship between earning and school quality for men born in 49 states in the United States between 1920 and 1949. The measures of the quality of public schooling include pupil-teacher ratio, the average length of the school term, and average annual teacher salaries. The regression analysis suggested that all three quality variables were strongly correlated with returns to education. The explanations are (1) increases in term length increase the economic value of additional years of schooling; 2) reductions in the pupil-teacher ratio improve the quality of classroom instruction and lead to higher returns for each year of completed education; and 3) higher teacher salaries enable schools to attract and retain more-qualified teachers, leading to improved classroom instruction and higher returns to education. Card and Krueger also compared the relation between educational quality and the returns to education for whites and blacks, and the positive impact of school quality on earnings for the two race groups is supported.

Research Design and Methodology

The research methodology and strategy is to use time series and cross section regressions to compare the different effects of school quality and the length of compulsory

schooling on school outcome. With interest in the average performance of all countries rather than a particular individual country, I use cross-country data with coverage of 142 countries and the period of 1960-90. Data resources are UNESCO's Statistical Yearbook(UNESCO, 1963-1992) and the World Bank's World Table.

The major dependent variables are $LITERACY_{it}$, $REPETITION1_{it}$ and $REPETITION2_{it}$ which indicate the school outcome. $LITERACY_{it}$ is defined as country i's adult literacy rate in period t. It reflects the average educational level of a country and can be used as a proxy for the median amount of investment on human capital (Azariadis and Drazen 1990, Anand and Ravallion 1993). Literacy rate in this study is the dependent variable as the indicator of long run school outcome. $REPETITION1\ (2)_{it}$ stands for the repetition rate in primary (secondary) education of country i in period t. Both primary and secondary repetition rates are measures of short-run school outcome in that the high repetition indicates low efficiency of educational investment (the United Nations 1990). The explanatory variables are $LENGTH_{it}$, $RATIO1_{it}$, $RATIO2_{it}$ $EXPEND1_{it}$, and $EXPEND2_{it}$. The $LENGTH_{it}$ is the length of compulsory schooling, represented by number of years of schooling required by a country's compulsory schooling law which indicates the school input quantity. $RATIO1(2)_{it}$ is defined as the student-teacher ratio at the primary (secondary) education of country i in period t. The student-teacher ratio reflects the school characteristics of input and relates to the school input quality. $EXPEND1(2)_{it}$ is defined as per student expenditures at the primary(secondary) education of country i in period t. This variable stands for the average public expenditure on each student at the primary(secondary) schools, which represents an alternative measure of school.

The multiple regression model is established based on a three-factor version of the Cobb-Douglas production function since it fits a variety of real-world situations (Brown 1991) and has been widely used in comparative studies of economic growth (Romer, Weil, and Mankiw 1990, Anand and Ravallion 1993).

(1) $$Q = b_0 X_1^{b1} X_2^{b2} X_3^{b3} e$$

In order to employ OLS estimation, a log transformation of the equation (1) will ensure an expression of "log linear" and will permit its estimation with linear regression. Taking natural logs of both sides of equation (1) yields

(2) $LogQ=Log(b_0)+b_1Log(X_1)+b_2Log(X_2)+b_3Log(X_3)+Loge.$

where: Q = school output represented by repetition rates for primary education (REPETITION1), repetition rates for secondary education (REPETITION2), and adult literacy rates (LITERACY).

X_i = school inputs (i=1,2,3) including length of compulsory schooling (LENGTH) as quantity of school input; per-pupil expenditures (EXPEND1 and EXPEND2), and student-teacher ratio (RATIO1 and RATIO2) as quality of school input

b_i = parameters to be estimated (i=0,1,2,3)

e = random error term

Based on Equation (2), this study estimates three logarithm-linear functions with the same input variables and different output variables. Model (3) uses a nation's adult literacy rate to represent long-term school outcome. Models (4) and (5) take repetition rate in primary and secondary education to measure short-term school outcome. Separate regressions of the three dependent variables in pooled time periods (1970, 1980, and 1990) are performed against the estimated values of LENGTH, EXPEND, and RATIO in their one-period lags (1960, 1970, 1980) respectively. The three regression models are:

(3) $Log(REPETITION1_{it})=a+b_{i1}Log(LENGTH_{i(t-1)})+b_{i2}Log(EXPEND_{i(t-1)})+b_{i3}Log(RATIO_{i(t-1)})+u,$

(4) $Log(REPETITION2_{it})=a+b_{i1}Log(LENGTH_{i(t-1)})+b_{i2}Log(EXPEND_{i(t-1)})+b_{i3}Log(RATIO1_{i(t-1)})+u,$

(5) $Log(LITERACY_{it})=a+b_{i1}Log(LENGTH_{i(t-1)})+b_{i2}Log(EXPEND_{i(t-1)})+b_{i3}Log(RATIO1_{i(t-1)})+u.$

The three equations (3), (4), and (5) are tested both for the panel data that incorporate all observations of three periods and for the cross-section data of each of the following three periods: 1960-70, 1970-80, and 1980-90. Measured by the degree of elasticity, the b_1s, b_2s, and b_3s in Equations (3) through (5) convey the information about the responsiveness of school outcome to changes in both quantity and quality of school inputs. In sum, these estimated coefficients will show whether and how the school quantity (the length of compulsory schooling) and school input quality (per student expenditure and student-teacher ratios) have different influences on school outcome.

Using the same framework, the regression analysis also examines that at the primary compulsory stage, the influence of the length of compulsory schooling on school outcome is likely stronger; and at the secondary compulsory schooling stage, the influence of school quality may be stronger. The test for stability of regression coefficients is structurally conducted. Ignoring the countries that do not implement compulsory schooling, I examine two country groups only: The countries with primary compulsory schooling laws and those with secondary compulsory schooling laws. To investigate the structural differences between the two country groups, a dummy variable D is introduced into the regression model.

(6) $$\text{Log}(\text{REPETITION1}_t) = a_{10}+(a_{11}-a_{10})D+b_{10}\text{Log}(\text{LENGTH}_{t-1}) +b_{20}\text{Log}(\text{EXPEND}_{t-1})+b_{30}\text{Log}(\text{RATIO}_{t-1})+(b_{11}-b_{10})D^*\text{Log}(\text{LENGTH}_{t-1}) +(b_{21}-b_{20})D^*\text{Log}(\text{EXPEND}_{t-1})+(b_{31}-b_{30})D^*\text{Log}(\text{RATIO}_{t-1})+u,$$

(7) $$\text{Log}(\text{REPETITION2}_t) = a_{10}+(a_{11}-a_{10})D+b_{10}\text{Log}(\text{LENGTH}_{t-1}) +b_{20}\text{Log}(\text{EXPEND}_{t-1})+b_{30}\text{Log}(\text{RATIO}_{t-1})+(b_{11}-b_{10})D^*\text{Log}(\text{LENGTH}_{t-1}) +(b_{21}-b_{20})D^*\text{Log}(\text{EXPEND}_{t-1})+(b_{31}-b_{30})D^*\text{Log}(\text{RATIO}_{t-1})+u,$$

(8) $$\text{Log}(\text{LITERACY}_t) = a_{10}+(a_{11}-a_{10})D+b_{10}\text{Log}(\text{LENGTH}_{t-1}) +b_{20}\text{Log}(\text{EXPEND}_{t-1})+b_{30}\text{Log}(\text{RATIO}_{t-1})+(b_{11}-b_{10})D^*\text{Log}(\text{LENGTH}_{t-1}) +(b_{21}-b_{20})D^*\text{Log}(\text{EXPEND}_{t-1})+(b_{31}-b_{30})D^*\text{Log}(\text{RATIO}_{t-1})+u,$$

where the dummy variable D is defined as:

D=0 for countries with primary compulsory schooling laws, D=1 for countries with secondary compulsory schooling laws. In equations (6) through (8), a_{10}, b_{10}, b_{20}, and b_{30} are assumed to be the relevant coefficients if a country executes primary compulsory schooling law, whereas a_{11}, b_{11}, b_{21}, and b_{31} are the relevant coefficients if a country executes secondary compulsory schooling law (a is constant term and u is error term).

A series of significance tests on structural change can be performed to compare the structural differences of the equations with primary compulsory schooling and those with secondary compulsory schooling. For each regression of equations (6) through (8), the null hypotheses are $a_{10}=a_{11}$, $b_{10}=b_{11}$, $b_{20}=b_{21}$, and $b_{30}=b_{31}$. To determine whether or not these hypotheses should be rejected, F-tests are performed. In addition, two tail t-tests are be used to determine the relative magnitude of coefficients between the two country groups. If coefficients between the two country groups are significantly different, the choice of the length of compulsory schooling will have discernible influence on the effect of those explanatory variables (school quantity and school quality) on school outcome. Thus, it is possible to find out which variable (school input quality versus school quantity) will play a more important role in achieving higher level of school outcome when primary compulsory schooling or secondary compulsory schooling is implemented.

Results and Analysis

Regression Analysis of Effects of School Quantity and Quality on School Outcome

We will first run regression models (3), (4), and (5). Because of the existence of a significant correlation between the explanatory variables of per-student expenditures and student-teacher ratios, I regress the dependent variables on EXPENDs and RATIOs respectively in order to overcome the problem of multiculinarity (Maddala 1988, Johnston 1988) which could damage regression results. For example, equation (3a) includes explanatory variables LENGTH, EXPEND1, and EXPEND2; the explanatory variables for equation (3b) are LENGTH, RATIO1, and RATIO2.

Table 2 presents the regression results of equation (3a) and equation (3b) in which the dependent variable is literacy rate (LITERACY). The regression results shown in

column (1), (3), and (5) demonstrate the effect on literacy rate of length of compulsory schooling ($LOGLENGTH_{t-1}$) and per-student expenditures in primary and secondary education ($LOGEXPEND1_{t-1}$ and $LOGEXPEND2_{t-2}$). Both length and per-student expenditures in primary education have positive influences on literacy rate. Comparing columns (3) with (5), we also find that the coefficient of $LENGTH_{t-1}$ decreased from .8345 in 1970-80 to .4842 in 1980-90, indicating that the influence of the length of compulsory school on literacy rate is diminishing over years. Per-student expenditures in secondary education ($LOGEXPEND2_{t-1}$) had a negative influence on the literacy rate in all three models which stress that primary education plays a more critical role in determining literacy rate than does secondary education. A large expenditure on primary compulsory schooling increases primary school quality, leading to a significant improvement in adult literacy level. Although an increase in spending on secondary education improves the secondary educational quality as well, it has no direct favorable effect on the literacy rate. On the contrary, with constant amounts of educational expenditures, more spending on secondary education necessarily results in less spending on primary education, reducing the quality of primary education and causing a lower literacy rate.

Columns (2), (4), and (6) show the estimated results for testing the effects on the literacy rate of length of compulsory schooling and student-teacher ratios in primary and secondary education ($LOGRATIO1_{t-1}$ and $LOGRATIO2_{t-1}$). The length of compulsory schooling, as a school quantity input, has a positive effect on the literacy rate. Comparing column (4) with column (6), we find the coefficient of $LOGLENGTH_{t-1}$ is not only smaller in 1980-90 but also less significant. This evidence once again indicates that the influence of school quantity diminishes over years. The student-teacher ratio in primary education ($LOGRATIO1_{t-1}$) has a significantly negative influence on the literacy rate; i.e., reducing class size in primary education will increase primary school quality and help improve the adult literacy level. The student-teacher ratio in secondary education ($RATIO2_{t-1}$) has no significant effect on literacy rate because the secondary educational quality has no direct influence on literacy rate.

Table 3 shows the estimated results from equation (4a) and (4b), where the dependent variable is repetition rate in primary education (REPETITION1). The estimated results in column (1), (2), and (3) show that length of compulsory schooling and per-student expenditures in primary education both have significantly negative effects on school repetition rate in primary education. This indicates that shorter length of compulsory schooling and lower spending per student in primary education tend to bring about a high repetition rate in primary education. The t-scores of coefficient of $LOGEXPEND2_{t-1}$ are not large enough to pass the significance test at the 10% level; therefore, per-student expenditures on secondary education are not associated with the repetition rate in primary education. Column (2), (4), and (6) present the estimated results of regressing repetition rate against length of compulsory schooling and student-teacher ratios in primary and secondary education. The longer years of compulsory schooling also cause a lower repetition rate. Since high student-teacher ratio implies low school quality, the positive effect of student-teacher ratio in primary education on repetition rate shows that a low student-teacher ratio leads to a low repetition rate in primary education.

Table 4 displays the estimated results of equation (5a) and (5b), the dependent variable is repetition rate in secondary education (REPETITION2). The length of compulsory schooling, per-student expenditures in both primary and secondary education have significant effects on repetition rate in secondary education. The explanation arises from the fact that spending in secondary education competes with spending in primary education when resources are limited. Since the success of secondary education is established subsequent to the success of primary education, low quality of primary education due to the deficient expenditures will typically cause a lower quality of secondary education.

Student-teacher ratios in both primary and secondary education have no significant influence on the repetition rate in secondary education according to the regression analysis. Since class size in primary and secondary education is relatively independent, i.e., class sizes in primary and secondary education do not affect each other, it is reasonable to assert that student-teacher ratio in primary education does not affect the secondary repetition

rate. Compared to total enrollment in elementary education, the total enrollment rate in secondary education throughout the world was about 45 percent in 1980, not quite half. Since fewer people enrolled in secondary education, the student-teacher ratio is relatively low. Therefore, it is not necessary to reduce class size because the reduction will not bring about significant change in the repetition in secondary education.

In brief, the estimated results of equation (3), (4), and (5) provide moderate support for the statement that length of compulsory schooling and school input quality have different effects on school outcome. Specifically, increases in the length of compulsory education and per-student expenditures in primary education raise the literacy rate, but a larger class size (represented by higher student-teacher ratio) in primary education appears to reduce the literacy rate. Increases in length of compulsory schooling and per-student expenditures in primary education lower repetition rates in both the first and second levels of education, while an increase in student-teacher ratio leads to a higher primary repetition rate. These results definitely confirm that increasing both school quantity and school quality inputs helps improve school outcome. In addition, over years, the influence of school quantity (length of compulsory schooling) becomes smaller and the effect of quality input becomes larger. This means that at the beginning stage of implementing compulsory schooling, quantity plays a more significant role in determining school outcome than quality. After the length reaches a certain level, school quality will substitute for quantity as the important contributing factor to school outcome.

Comparing the Effects of School Quality and Quantity between Implementations of Primary and Secondary Compulsory Schooling

Furthermore, it is interesting to explore the following issue: Under what circumstances will school quantity contribute more to school outcome than school quality, or vice versa? More specifically, does school quantity (length of compulsory schooling) contribute more to school outcome than school quality in the primary stage of education, or in the secondary stage of education?

Tables 5, 6, and 7 present the regression results for comparing the different contributions of two data groups. One subsample group (D=0) includes the countries implementing primary compulsory schooling (length of compulsory schooling is not greater than seven years), and the other group (D=1) contains the countries having secondary compulsory schooling (the length is not less than eight years). Equations (6a), (7a), and (8a) use the explanatory variables of length of compulsory schooling ($LOGLENGTH_{t-1}$) and per-student expenditures in primary and secondary education ($LOGEXPEND1_{t-1}$ and $LOGEXPEND2_{t-1}$). Equations (6b), (7b), and (8b) include the explanatory variables of length of compulsory schooling and student-teacher ratios in primary and secondary education ($LOGRATIO1_{t-1}$ and $LOGRATIO2_{t-1}$).

Table 5 displays the regression results of estimating equation (6a) and equation (6b) for the group of countries implementing primary compulsory schooling and the group of countries with secondary compulsory schooling. The dependent variable here is the log form of adult literacy rate (LOGLITERACY). By conducting the Chow test, it is determined that the contributions of length of compulsory schooling and school quality to literacy rate vary between the country group with primary compulsory schooling and the group with secondary to determine whether the marginal contributions of school quantity and quality to school outcome are structurally identical between the two country groups.

Comparing row (2) with row (12) in column (1), it is found that, for the group with primary compulsory schooling (D=0), the coefficient of length of compulsory schooling ($LOGLENGTH_{t-1}$) is significant and the magnitude is 0.5438; for the group with secondary compulsory schooling (D=1), the same coefficient is insignificant and the degree is 0.0477. Comparing row (3) with row (13) in the same column, the coefficient of per-student expenditures in primary education ($LOGEXPEND1_{t-1}$) is significant for both groups; however, for the group with primary compulsory schooling (D=0), the magnitude is 0.2486, which is less than 0.3091 for the group with secondary compulsory schooling (D=1). In addition, comparing row (2) with (12) in column (2), and row (5) with (15) in the same column, I find that the degree of contribution of length of compulsory schooling to literacy rate is greater in the group of countries with primary compulsory schooling,

while the contribution of student-teacher ratio in primary education to the literacy rate is larger for the country group with secondary compulsory schooling.

Table 6 shows the regression results for estimating equation (7a) and (7b), and the dependent variable is repetition rate in primary education (LOGREPETITION1). An examination of column (1) of Table 6 reveals that the coefficient of school quantity ($LOGLENGTH_{t-1}$) is -2.4482 for the group with primary compulsory schooling (D=0), whereas the same coefficient is -1.6476 for the group with secondary compulsory schooling (D=1). The coefficient of school quality, such as per-student expenditures in primary compulsory schooling ($LOGEXPEND1_{t-1}$), is nevertheless -0.2636 for the group of D=0 with its absolute value less than -0.5088 (the counterpart for the group of D=1). A similar result is found in column (2). The contribution of school quantity ($LOGLENGTH_{t-1}$) to repetition rate in primary education is significant and the degree of such a marginal contribution is -1.4957 for the group with primary compulsory schooling (D=0). For the group with secondary compulsory schooling (D=1), the coefficient of $LOGLENGTH_{t-1}$ is insignificant and its magnitude is only -0.6069. In terms of the contribution of student-teacher ratio in primary education ($LOGRATIO1_{t-1}$) to the repetition rate in primary education, the magnitude for the group D=0 is 1.0262, which is less than 1.1242 for the group D=1.

Table 7 displays the regression results for estimating the equations (8a) and (8b) with the dependent variable here being repetition rate in secondary education (LOGREPETITION2). Because of the insignificance of F value in Chow test, it is not be able to conclude that the contributions of length of compulsory schooling and school quality to repetition rate in secondary education vary between the two groups (D=0 and D=1). As we have analyzed the regression models (5a) and (5b) in Table 4, the development of secondary education is different from the development of primary education. The total enrollment rate in secondary education was only 45 percent, less than half of the enrollment rate in primary education. In some developing countries with primary compulsory schooling policy, only a small proportion of people are able to attend secondary schools. Therefore, classrooms in secondary schools are not as crowded as in

elementary schools; thus secondary school input quality for two country groups with primary and secondary compulsory schooling is not significantly different. Therefore, the repetition rate in secondary education is not significantly different for the two groups either.

Although the differences of the contributions of school quantity and quality to the repetition rate in secondary education between the two groups are not significant, the findings with regard to literacy rate and repetition rate in primary education may still indicate that, in terms of school outcome, increasing school quantity (length of compulsory schooling) will benefit the countries with primary compulsory schooling more than the countries with secondary compulsory schooling. For example, the contributions of length of compulsory schooling to the literacy rate and primary repetition rate for the group with primary compulsory schooling are larger than those for the group with secondary compulsory schooling. Therefore, increasing the length tends to bring about greater outcome in the primary stage than in the secondary stage of compulsory schooling. After the length has reached a certain high level, such as eight years, the contribution of the length to the literacy rate becomes diminishing. Hence, increasing per-student expenditures or reducing class size can contribute to a high literacy rate and a low repetition rate more in secondary than in primary compulsory schooling. Therefore, in the stage of secondary education, improving school quality input is more efficient than increasing length of compulsory schooling.

Conclusions

School quantity and school quality are two inter-related aspects of educational development and neither can be overlooked in policy-making. However, since we have only limited resources available for education, it is often difficult to increase both inputs. Therefore, we would like to know when increasing school quantity will make a greater contribution to school outcome and when improving school quality will do so. The regression analysis compares the contribution of length of compulsory schooling and school

quality to school outcome at two stages -- the primary compulsory schooling stage and the secondary compulsory schooling stage.

First, increasing both school quantity and quality make significant contributions to school outcome. For example, the length of compulsory schooling and the per-student expenditure in primary education have positive influence on literacy rate and negative influence on repetition rate. The student-teacher ratio in primary education has a negative effect on literacy rate and positive effect on repetition rate.

In addition, the results show that the favorable effects of length of compulsory schooling on school outcome diminish over time, which coincides with the law of diminishing returns. In the beginning stage of compulsory schooling, quantity plays a more important role in determining school outcome than quality. After the length reaches a certain level, school quality will substitute for quantity as the important factor in school outcome.

When the comprehensive sample is divided into two subsamples--countries implementing primary compulsory schooling and countries implementing secondary compulsory schooling--the regression results are consistent with the hypothesis. For the group with primary compulsory schooling, the contribution of length to school outcome is larger than for the group with secondary compulsory schooling. Therefore, increasing the length tends to bring about greater output in the primary stage of compulsory schooling than in the secondary stage. For the group with secondary compulsory schooling, the improvement of school quality (such as increasing per-student expenditures or reducing class size in primary schools) produces larger contributions to school outcome. Hence, improving school quality proves more efficient in the stage of secondary compulsory schooling.

Third, this study further finds that even though improving primary school quality does make a significant contribution to school outcome, secondary school quality has no significant influence on school outcome. The regression results show that per-student expenditures in secondary education and student-teacher ratio in secondary schools make no contribution to the literacy or repetition rates. Moreover, per-student expenditures in

secondary education appear to have a negative influence on the literacy rate and positive effect on the repetition rate. These findings emphasize the critical role of primary school quality. While large expenditures on primary education lead to a significant improvement in adult literacy rate and low repetition rates, an increase in spending on secondary education has no direct favorable effect on school outcome even though it certainly improves secondary school quality. With constant amounts of educational expenditures, more spending on secondary education necessarily results in less spending on primary education, reducing the quality of primary education and causing a lower school outcome.

Therefore, lengthening compulsory schooling is not independent on raising school quality. Without a corresponding improvement in school input quality, increasing length of compulsory schooling will have a declining effect on quality of school outcome. Especially along with progress in educational expansion, the interrelationship between school quantity and quality becomes more critical for efficiency in educational expansion. The average school input quality for developing countries is relatively low; thus, while these countries increase the length, they should pay sufficient attention to improve school input quality simultaneously.

More specifically, for countries with only primary compulsory schooling policy, increasing length produces large benefits in terms of school outcome. For countries with secondary compulsory schooling policy, school outcome does not appear to benefit much from increased length. Instead, improving school input--increasing per-student expenditures and reducing class size--can contribute more to school outcome. Therefore, it is important for a nation to understand when to invest more in quantity and when to invest more in improving quality.

For example, a country with six years of compulsory schooling, that advances to a seven-year compulsory schooling program will likely gain considerable benefit in terms of increased high school outcome. In contrast, when a nation has eight or nine years of compulsory schooling, simply increasing length without improving input quality will diminish the effectiveness of its policy. Under these circumstances, improvement of school input quality should be recommended instead.

Considering the importance of compulsory schooling for a developing country's economic growth and social progress, this study suggests the following order of implementing the compulsory schooling: The fundamental step is to achieve a rudimentary compulsory schooling, which is indispensable for every country. The next step that should be taken is to check up on the cornerstone to ensure the quality of this minimal level of compulsory schooling. Step three then involves extending more years of schooling on the basis of rudimentary compulsory schooling. The subsequent step concerns further improvement the quality of the added years.

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Table 1. Descriptions of the Variables

LENGTH	Length of Compulsory Schooling
LITERACY	Adult Literacy Rate
REPETITION1	Repetition Rate for Primary Education
REPETITION2	Repetition Rate for Secondary Education
RATIO1	Student-Teacher Ratio in Primary Education
RATIO2	Student-Teacher Ratio in Secondary Education
EXPEND1	Per-Pupil Expenditures in Primary Education
EXPEND2	Per-Pupil Expenditures in Secondary Education
EXPEND	Per-Pupil Expenditures in Basic Education

Table 2 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on LITERACY

Dependent Variable: Log(LITERACY)

	1960-90		1970-80		1980-90	
	Eq(3a)	Eq(3b)	Eq(3a)	Eq(3b)	Eq(3a)	Eq(3b)
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	3.0921[a]	6.4366[a]	2.1211[a]	3.9641[a]	2.8556[a]	6.0437[a]
	(7.48)	(9.11)	(3.85)	(3.54)	(5.77)	(7.46)
$LOGLENGTH_{t-1}$	0.2301	0.4074[b]	0.8325[a]	1.1099[a]	0.4842[c]	0.2894
	(0.96)	(2.07)	(2.61)	(3.63)	(1.68)	(1.21)
$LOGEXPEND1_{t-1}$	0.4337[a]		0.3611[a]		0.2666[a]	
	(6.54)		(3.94)		(3.27)	
$LOGEXPEND2_{t-1}$	-0.2987[a]		-0.2767[a]		-0.1831[c]	
	(-3.86)		(-2.67)		(-1.79)	
$LOGRATIO1_{t-1}$		-1.0358[a]		-0.5872[b]		-0.8825[a]
		(-6.58)		(-2.09)		(-5.05)
$LOGRATIO2_{t-1}$		0.0542		-0.0718		0.1265
		(0.35)		(-0.30)		(0.73)
R^2	0.3177	0.3096	0.4055	0.3941	0.4051	0.4562
F value	28.094	33.925	14.326	14.743	12.715	22.37
RSS	71.803	100.92	13.725	19.195	10.273	15.06
N	185	231	67	72	60	84

Note: 1. [a], [b], and [c] refer to 1%, 5%, and 10% significance levels, respectively.

2. N denotes the number of observations.

3. RSS stands for the residual sum of squares.

Table 3 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on REPETITION1

Dependent Variable: Log(REPETITION1)

	1960-90		1970-80		1980-90	
	Eq(4a)	Eq(4b)	Eq(4a)	Eq(4b)	Eq(4a)	Eq(4b)
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	5.8631[a]	0.6895	4.7715[a]	0.4440	6.2322[a]	0.8548
	(6.39)	(0.55)	(3.38)	(0.21)	(5.01)	(0.54)
$LOGLENGTH_{t-1}$	-1.7502[a]	-0.9250[b]	-0.5788	-0.3726	-2.2313[a]	-1.1141[b]
	(-3.27)	(-2.25)	(-0.69)	(-0.54)	(-3.15)	(-2.15)
$LOGEXPEND1_{t-1}$	-0.2492[c]		-0.3533[c]		-0.2477[c]	
	(-1.86)		(-1.79)		(-1.31)	
$LOGEXPEND2_{t-1}$	0.1561		0.0655		0.2369	
	(0.90)		(0.27)		(0.96)	
$LOGRATIO1_{t-1}$		1.0076[a]		0.6541		1.1744[a]
		(3.14)		(1.11)		(3.03)
$LOGRATIO2_{t-1}$		-0.0363		0.1234		-0.1795
		(-0.11)		(0.23)		(-0.44)
R^2	0.2172	0.2437	0.1982	0.1067	0.2452	0.3067
RSS	122.03	130.05	49.554	45.842	64.602	78.631
F value	10.175	14.725	3.8728	1.9112	6.1737	12.242
N	114	141	51	52	61	87

Note: 1. [a], [b], and [c] refer to 1%, 5%, and 10% significance levels, respectively.

2. N indicates the number of observations.

3. RSS stands for the residual sum of squares.

Table 4 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on REPETITION2

Dependent Variable: Log(REPETITION2)

	1960-90		1970-80		1980-90	
	Eq(5a)	Eq(5b)	Eq(5a)	Eq(5b)	Eq(5a)	Eq(5b)
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	4.6678[a]	1.1287	5.0360[a]	1.2318	4.5068[a]	1.2743
	(4.26)	(0.73)	(2.87)	(0.59)	(5.01)	(0.58)
$LOGLENGTH_{t-1}$	-1.8693[a]	-0.6989[c]	-1.4649[c]	-0.4663	-2.1242[b]	-0.7635
	(-3.13)	(-1.39)	(-1.68)	(-0.66)	(-2.51)	(-1.09)
$LOGEXPEND1_{t-1}$	-0.3533[b]		-0.3152		-0.4727[c]	
	(-1.98)		(-1.34)		(-1.75)	
$LOGEXPEND2_{t-1}$	0.4643[b]		0.2247		0.6920[b]	
	(2.10)		(0.77)		(2.03)	
$LOGRATIO1_{t-1}$		0.4502		-0.1347		0.8417
		(1.15)		(-0.25)		(1.53)
$LOGRATIO2_{t-1}$		0.2351		0.7048		-0.2047
		(0.56)		(1.35)		(-0.32)
R^2	0.1540	0.1007	0.1877	0.0959	0.1620	0.1092
RSS	103.79	141.72	32.391	34.974	66.850	102.76
F value	5.159	4.217	2.620	1.414	2.965	2.779
N	89	117	38	44	50	72

Note: 1. [a], [b], and [c] refer to 1%, 5%, and 10% significance levels, respectively.

2. N indicates the number of observations.

3. RSS stands for the residual sum of squares.

Table 5 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on LITERACY for D=0 and D=1

Dependent Variable: Log(LITERACY)

	1960-90		1970-80		1980-90	
	Eq(6a)	Eq(6b)	Eq(6a)	Eq(6b)	Eq(6a)	Eq(6b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=0 (the subsample including countries that implement only primary compulsory schooling)						
(1) Constant	2.8364[a]	4.6074[a]	2.0899[c]	6.2976[a]	3.9226[a]	5.7047[a]
	(4.32)	(4.28)	(1.85)	(2.70)	(4.67)	(3.50)
(2) $LOGLENGTH_{t-1}$	0.5438[c]	0.8545[a]	1.0676[c]	0.8304	-0.1903	0.2936
	(1.46)	(2.75)	(1.58)	(1.21)	(-0.41)	(0.54)
(3)$LOGEXPEND1_{t-1}$	0.2486[b]		0.5255[a]		0.0305	
	(2.38)		(3.06)		(0.25)	
(4)$LOGEXPEND2_{t-1}$	-0.1860[c]		-0.5067[a]		0.1016	
	(-1.61)		(-2.68)		(0.68)	
(5)$LOGRATIO1_{t-1}$		-0.5172[b]		-1.0172[b]		-0.8900[b]
		(-2.07)		(-2.00)		(-2.04)
(6)$LOGRATIO2_{t-1}$		-0.1637		-0.1523		0.2754
		(-0.86)		(-0.34)		(0.86)
(7) R^2	0.1391	0.1790	0.3351	0.2535	0.2249	0.1861
(8) RSS	22.76	32.24	9.710	11.30	1.135	6.261
(9) F value	3.789	6.539	4.537	3.057	1.064	1.906

(10) N	74	94	31	31	15	29

Table 5 (Continued)

	1960-90		1970-80		1980-90	
	Eq(6a)	Eq(6b)	Eq(6a)	Eq(6b)	Eq(6a)	Eq(6b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=1 (the subsample including countries that implement only secondary compulsory schooling)						
(11)Constant	3.4671[a]	7.0946[a]	2.2710[b]	2.2206[c]	2.5425[a]	5.9879[a]
	(6.17)	(8.78)	(2.51)	(1.84)	(3.67)	(5.83)
(12)LOGLENGTH$_{t-1}$	0.0477	0.0846	0.6257	1.8418[a]	0.6709[c]	0.2907
	(0.17)	(0.31)	(1.53)	(3.99)	(1.75)	(0.90)
(13)LOGEXPEND1$_{t-1}$	0.3091[a]		0.1693[b]		0.3035[a]	
	(4.29)		(1.99)		(2.46)	
(14)LOGEXPEND2$_{t-1}$	-0.1709[b]		-0.0461		-0.2340[c]	
	(-2.02)		(-0.47)		(-1.65)	
(15)LOGRATIO1$_{t-1}$		-1.1834[a]		-0.1731		-0.9946[a]
		(-6.11)		(-0.55)		(-4.41)
(16)LOGRATIO2$_{t-1}$		0.2529		-0.4995[b]		0.2732
		(1.29)		(-1.95)		(1.23)
(17) R^2	0.3515	0.4069	0.3634	0.4274	0.3897	0.5013
(18) RSS	15.65	22.43	2.73	4.08	5.288	5.777
(19) F value	15.36	23.10	5.709	8.212	7.024	13.739
(20) N	89	105	34	37	37	45

Note: 1. [a], [b], and [c] refer to 1%, 5%, and 10% significance levels, respectively.

2. N denotes the number of observations.

3. RSS stands for the residual sum of squares.

Table 6 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on REPETITION1 for D=0 and D=1

Dependent Variable: Log(REPETITION1)

	1960-90		1970-80		1980-90	
	Eq(7a)	Eq(7b)	Eq(7a)	Eq(7b)	Eq(7a)	Eq(7b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=0 (the subsample including countries that implement only primary compulsory schooling)						
Constant	7.0336[a]	3.4404[c]	4.9219[b]	4.9535	13.1903[a]	4.9011[c]
	(3.63)	(1.62)	(2.46)	(1.42)	(3.71)	(1.79)
$LOGLENGTH_{t-1}$	-2.4482[b]	-1.4957[c]	-0.7661	-0.5901	-5.4154[a]	-2.9531[b]
	(-2.26)	(-1.79)	(-0.58)	(-0.53)	(-3.11)	(-2.42)
$LOGEXPEND1_{t-1}$	-0.2130		-0.5554[b]		0.2256	
	(-0.91)		(-2.03)		(0.65)	
$LOGEXPEND2_{t-1}$	0.1403		0.3022		-0.4286	
	(0.45)		(0.84)		(-0.91)	
$LOGRATIO1_{t-1}$		1.0262[b]		0.8977		0.9438
		(1.99)		(1.35)		(1.27)
$LOGRATIO2_{t-1}$		-0.6144		-1.4856[c]		-0.1265
		(-1.23)		(-2.01)		(-0.19)
R^2	0.1707	0.1327	0.2468	0.1829	0.4797	0.2533
RSS	42.20	48.78	17.96	15.20	12.02	26.77

F value	2.401	2.599	2.075	1.417	3.688	2.941
N	39	53	23	23	16	30

Table 6 (Continued)

	1960-90		1970-80		1980-90	
	Eq(7a)	Eq(7b)	Eq(7a)	Eq(7b)	Eq(7a)	Eq(7b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=1 (the subsample including countries that implement only secondary compulsory schooling)						
Constant	5.6067[a]	-1.1652	5.6213[c]	2.9944	5.5565[a]	-2.3204
$LOGLENGTH_{t-1}$	-1.6476[b]	-0.6069	-1.1473	-2.0445[c]	-1.8468[c]	-0.1297
$LOGEXPEND1_{t-1}$	-0.5088[a]		-0.5982[c]		-0.5407[c]	
	(-2.45)		(-1.75)		(-1.87)	
$LOGEXPEND2_{t-1}$	0.4125[c]		0.3554		0.5031	
	(1.63)		(0.91)		(1.40)	
$LOGRATIO1_{t-}$		1.1242[b]		-0.0154		1.4789[a]
		(2.25)		(-0.02)		(2.46)
$LOGRATIO2_{t-1}$		0.2686		1.2634[c]		-0.1342
		(1.56)		(1.54)		(-0.21)
R^2	0.2439	0.3232	0.2669	0.3758	0.2274	0.3164
RSS	61.51	61.09	22.30	15.87	33.95	39.48
F value	6.343	11.30	2.670	4.617	3.041	6.479
N	63	75	26	27	35	46

Note: 1. [a], [b], and [c] indicate 1%, 5%, and 10% significance levels, respectively.

2. N denotes the number of observations.
3. RSS stands for the residual sum of squares.

Table 7 Estimated Effects of LENGTH, EXPEND1, EXPEND2, RATIO1, and RATIO2 on REPETITION2 for D=0 and D=1

Dependent Variable: Log(REPETITION2)

	1960-90		1970-80		1980-90	
	Eq(8a)	Eq(8b)	Eq(8a)	Eq(8b)	Eq(8a)	Eq(8b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=0 (the subsample including countries that implement only primary compulsory schooling)						
Constant	7.2618[a]	3.7793[c]	7.7775[b]	7.1850[c]	6.9772[c]	1.9118
	(3.11)	(1.51)	(2.44)	(1.75)	(1.70)	(0.56)
$LOGLENGTH_{t-1}$	-3.0492[b]	-1.0063	-2.9927[c]	-1.0617	-3.0935	-1.0623
	(-2.51)	(-1.05)	(-1.96)	(-0.73)	(-1.26)	(-0.80)
$LOGEXPEND1_{t-1}$	-0.2636		-0.2879		-0.2193	
	(-0.94)		(-0.92)		(-0.32)	
$LOGEXPEND2_{t-1}$	0.2950		0.2045		0.3187	
	(0.79)		(0.46)		(0.37)	
$LOGRATIO1_{t-1}$		-0.3524		-0.7843		0.0758
		(-0.64)		(-1.01)		(0.09)
$LOGRATIO2_{t-1}$		0.4618		-0.1636		0.6634
		(0.77)		(-0.17)		(0.79)
R^2	0.2178	0.0508	0.3513	0.1446	0.1217	0.1121
RSS	30.84	38.22	11.08	12.67	19.53	22.38
F value	2.599	0.549	2.166	0.789	0.554	0.926
N	32	44	16	18	16	26

Table 7 (Continued)

	1960-90		1970-80		1980-90	
	Eq(8a)	Eq(8b)	Eq(8a)	Eq(8b)	Eq(8a)	Eq(8b)
	(1)	(2)	(3)	(4)	(5)	(6)
D=1 (the subsample including countries that implement only secondary compulsory schooling)						
Constant	5.1199[b]	-0.8821	2.5342	0.7127	5.3795[b]	-0.2320
	(2.37)	(-0.33)	(1.25)	(0.20)	(2.01)	(-0.05)
$LOGLENGTH_{t-1}$	-1.9494[c]	-0.3341	-1.5092	-1.1945	-2.4716[c]	-0.3050
	(-1.77)	(-0.34)	(-0.74)	(-0.78)	(-1.71)	(-0.22)
$LOGEXPEND1_{t-1}$	-0.4878[c]		-0.2626		-0.7529[b]	
	(-1.88)		(-0.65)		(-2.09)	
$LOGEXPEND2_{t-1}$	0.5588[c]		0.1272		0.9515[b]	
	(1.81)		(0.27)		(2.16)	
$LOGRATIO1_{t-1}$		1.1865[b]		0.6351		1.6608[b]
		(1.95)		(0.76)		(1.94)
$LOGRATIO2_{t-1}$		-0.1623		0.5699		-0.9559
		(-0.26)		(0.79)		(-0.95)
R^2	0.1401	0.1509	0.1177	0.2847	0.2128	0.1316
RSS	65.21	91.80	19.56	16.64	40.26	70.79
F value	2.609	3.737	0.756	2.654	2.343	1.920
N	52	67	21	24	30	42

Note: 1. [a], [b], and [c] refer to 1%, 5%, and 10% significance levels, respectively.

2. N indicates the number of observations.

3. RSS stands for the residuals sum of squares.