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Determinants of International Differences in Educational Effort

by

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The vital role played by education as an input in the processes of economic growth and development has been extensively documented.[1] Much less attention has been given to the determinants of the amount of education produced,[2] even though the persistence of extremely large international differences in this respect is common knowledge and there is continuing, widespread concern with the severe educational deficiencies of many less-developed countries.[3] The present paper represents an attempt to identify and measure these determinants, as they operate within an international cross-section, and to place them within a systematic framework. It is hoped that both the substantive results and the methodology will contribute to further investigation of a topic which remains incompletely explored.

The development of a model is presented in Part I of this paper. In Part II, statistical results from application of the model are discussed. Part III, also devoted to empirical results, pertains to differences between the more-developed and the less-developed countries. The principal findings of the study are summarized in Part IV.

I. The Model

In the absence of an acceptable means of gauging international differences in the effectiveness of the education process, the concept of "educational effort" serves as the focal point of this study. Stated in the most general form, the educational effort made by a given country, within a particular time period, may be expressed by three identities:

$$X \equiv N(X/N)$$

$$N \equiv X(N/X)$$

$$X/N \equiv X(1/N) \quad .$$

Where, X = educational expenditure, N = enrollment, and X/N = outlay per pupil. Within broad limits, these are policy variables, representing "decisions" on how much of national output is to be allocated to education, how many of the young people are to be schooled, and how much is to be spent on each student. The indeterminancy of this simple model reflects the closely interrelated nature of these decisions. In order to ascertain the actual pattern of decision-making, the model is respecified in determinate and testable form, and disaggregated into "lower" and "higher" levels. The former refers to primary and secondary education combined; the latter to university and other post-secondary schooling.[4] Outlay per pupil is dropped as an explicit element, and inferred from the enrollment-spending relationships.

Regression analysis is used to estimate the parameters of expenditure and enrollment. Because of the simultaneity linking these variables, two-stage least squares estimators are employed. The regression population consists of a cross-section of the 44 countries, both MDCs and LDCs, for which the required data are available.[5]

The model incorporates an adjustment designed to minimize any endogenous effects on presumably exogenous variables. Such effects could be induced, particularly, by the interaction between educational effort and the age structure of a population: the length of the period of education directly affects marriage rates, which in turn influence continuation in school; further, both age at marriage and educational attainment have a considerable bearing on current fertility (and thus influence age structure).[6] In order to insulate the model from this and similar effects, insofar as possible, all variables in which population is the denominator are adjusted to exclude the 0-4 age bracket, the relative size of which is determined primarily by current birth rates.[7] As noted below, the design of the model also reflects efforts to minimize the related problem of collinearity among explanatory variables.

The equations comprising the basic model are shown below:

$$\ln NL_i = a_0 + a_1 \ln \widehat{XL}_i + a_2 \ln \overline{PL}_i + a_3 \ln \overline{S}_i + \mu_{NLi} \quad (1.00)$$

$$\ln XL_i = b_0 + b_1 \ln \widehat{NL}_i + b_2 \ln \overline{Y}_i + b_3 \ln \overline{F}_i + b_4 \overline{A}_i + \mu_{XLi} \quad (2.00)$$

$$\ln NH_i = c_0 + c_1 \ln \widehat{XH}_i + c_2 \ln \overline{S}_i + c_3 \ln \overline{PH}_i + \mu_{NHi} \quad (3.00)$$

$$\ln XH_i = d_0 + d_1 \ln \widehat{NH}_i + d_2 \ln \overline{Y}_i + d_3 \ln \overline{F}_i + d_4 \overline{A}_i + \mu_{XHi} \quad (4.00)$$

where

NL = percent of population enrolled in lower education

XL = per capita expenditure on lower education

PL = percent of population in lower education ages

S = enrollment rate in secondary education, lagged

Y = per capita income

F = foreign aid receipts, per capita

A = African or non African country

NH = percent of population enrolled in higher education

XH = per capita expenditure on higher education

PH = percent of population in higher education ages .

All equations in the system are clearly over-identified. Use of the logarithmic form for all variables (other than $\overline{A}$) improves the fit of most equations, and has the added advantage that the coefficients directly measure elasticities. Subscripts denote the i^{th} country within the cross-section; however, the various subscripts, overbars, and indications of logarithmic form are henceforth omitted for greater simplicity. Except where otherwise stipulated, the time reference is to the year 1965 (approximately). The u's represent, of course, statistical error. Positive signs are hypothesized throughout the model, but elasticities are often the more meaningful parameters. The equations and their constituent variables are further described below.

The hypothesized determinants of enrollment at the primary and secondary, or "lower", levels comprise the first equation. The dependent variable, NL, represents the percentage of the total (adjusted) population enrolled in public and private institutions at these levels.[8]

XL, an endogenous variable, measures recurring, (non-capital) public spending on lower education, per capita and per annum, in U.S. dollar equivalents.[9] Public subsidies to private schooling are included in XL, but purely private expenditures are not, so there is a degree of incomparability with the enrollment variable, but the discrepancy is not large.[10]

PL gauges the relative size of the population in the lower schooling ages, i.e. the population aged 5-19 as a percent of the adjusted total.[11] The three five-year cohorts comprising this age group are weighted to adjust for differences in enrollment rates within the 15-year span.[12] The PL coefficient measures the elasticity of enrollment with respect to the school-age population. It is expected to be less than one, reflecting the commonly-held belief that the percentage of school-age persons enrolled tends to vary inversely with the proportion of the population in that age bracket.[13] The relative size of this age group varies greatly among the countries in the sample: it ranges from less than 25 percent (of the adjusted population) in such advanced nations as Sweden and West Germany to over 45 percent in a number of the LDCs. In general, differences in population age structure are attributable to the combined effects of past and present fertility, mortality, and migration, but it has been shown that the proportion of younger persons is primarily a function of the birth rate.[14]

S is a lagged variable, measuring the percentage of the age group 15-19 enrolled in secondary schools in 1955. It is intended to serve as a proxy for the potential supply of primary-school teachers, who in most countries are trained at the secondary level.[15] Instructors above the primary grades are more easily recruited from abroad, and thus are less likely to comprise a bottleneck in an expanding educational system.[16]

The second equation specifies the determination of public expenditures at the lower educational level. Both XL and NL have already been defined. In this equation, the NL coefficient shows the elasticity of expenditure with respect to enrollment. Y is per capita GNP, in U.S. dollars; its coefficient indicates the income elasticity of educational spending.[17] F represents the net official flow of external resources to the developing nations, measured in U.S. dollars per capita, on an annual average basis for the period 1962-65.[18] Foreign aid may contribute to educational spending in any or all of three ways: (1) funds may be earmarked for educational purposes; (2) aid may be used to finance the foreign exchange component of external inputs into education; and (3) a government's command of domestic resources may be augmented by the flow of revenue from abroad.[19]

The final explanatory component of the second equation is a dummy variable designating all countries: 1 = Africa, 0 = all other regions. The underlying hypothesis is simply that some countries spend more (or less) on education than would be expected on the basis of the observed determinants. When these countries comprise an identifiable subset, as in a regional grouping, the use of a variable designating their distinctive pattern of behavior is logically indicated. In earlier versions of this model, regional variables for the Asian and Latin American countries failed to yield significant results. The identification of the African nations as a meaningful subset is the outcome, therefore, of statistical experimentation rather than of a priori hypothesizing.

Separate equations are used to estimate enrollment and expenditure parameters for higher education. At the least, the relevant age group differs from that pertaining to lower-level schooling. Other possible variations in the explanatory pattern may be explored through this approach. Disaggregation also serves the purpose of making some implicit allowance for the complementary and competitive elements of the relationship between effort at different levels, inasmuch as all the endogenous variables are regressed against a common set of predetermined variables.[20]

The dependent variable in equation 3.00 is NH, which represents the percentage of a country's population enrolled in public and private institutions of higher education.[21] XH, a measure of per capita expenditures on higher education, refers only to public spending (including government subsidies to private institutions, but excluding outlays from private sources.)[22] The previously-defined S variable makes its second appearance in this equation, but with some difference in its role. Here its function is to gauge the supply of secondary school graduates, from among whom college and university students must be drawn. The last variable, PH, is the relative size of the population in the higher-education age brackets, for which the sum of the 15-19 and 20-24 age groups serves as a proxy.[23] The role of this variable parallels that of PL in equation 1.00, but is not expected to be nearly as important, given the customary constraints on entry into institutions of higher education.

The final equation in the system is designed to estimate the parameters of public outlays for higher education. In construction and underlying rationale it is identical with equation 2.00, except that the expenditure and enrollment variables, XH and endogenous NH, refer to post-secondary schooling.[24]

II. Statistical Results

Results of the TSLS regressions for the entire 44-country sample are shown in Table 1-A. The regressions attain extremely high levels of significance, and in all cases explain at least four-fifths of observed variance. The endogenous terms have positive signs, as hypothesized, and in three out of four instances are significant at five percent (or better), essentially fulfilling the expectation of an interdependent system. (These and subsequent references to the significance of regression variables are based on one-tailed t-tests.)

In the main, the regression results appear to be relatively free of multicollinear effects, with the exception of equation 4.00. That equation, which is discussed below, is respecified(as 4.01). Elsewhere in the model, there are several relatively strong pairwise correlations among explanatory variables.[25] In all but one of these, however, the very high levels of significance shown by the relevant terms indicate that multicollinearity did not substantially influence the regression coefficients.[26] As a further precaution against errors arising from collinearity, the regression population is segmented into LDC and MDC subsets, with results that are treated in a subsequent section of this paper.

All explanatory variables in equation 1.00 are significant at the one percent level, but the beta coefficients (regression coefficients made fully comparable by conversion into standardized units) point to the lagged secondary schooling variable as the principal single determinant. This result lends credence to the hypothesis regarding the supply of secondary school graduates, and indicates the strong influence that past educational effort may exert on current performance.

The endogenous expenditure variable in 1.00 shows a highly significant and direct association with enrollment, but the coefficient is strikingly small. It would appear, therefore, that increases in educational spending, within the international cross-section, result mainly in larger outlays per pupil rather than in enrollment gains.

Taken at face value, the PL coefficient is clearly anomalous, in that the elasticity of enrollment with respect to the school-age population exceeds unity by a margin that is statistically significant (at five percent). Possible explanations for the exaggerated value of this coefficient are considered below.

(1) A number of countries may tend to inflate their enrollment statistics, and this tendency may be positively correlated with the size of the school-age population and negatively related to actual enrollment rates.

(2) The presence of an especially large fraction of young people in the population may serve as a stimulus to the expansion

of enrollment, in the form of spreading outlays more thinly among a greater number of pupils.

(3) Collinearity between the PL and XL variables (r = -.68) may have affected the coefficients of both terms. This is the least likely explanation, however, in view of the almost identical PL coefficient that occurs in a separate regression for the LDC subset, where there are no signs of collinearity, (r = .03).

(4) Neither the adjustment of the population denominator nor the weighting of the five-year components of the age 5-19 population is responsible for this result. On the contrary, these procedures had the effect of reducing the PL coefficient.[27]

Perhaps the most reasonable way out of this difficulty may be to assign to PL a "corrected" coefficient approximating unity. This would mean that the school-age population sets only an upper limit to enrollment (which rises at the margin in a constant relationship).

The results for equation 2.00 make it clear that per capita income and the regional dummy are the principal determinants of outlays for lower-level schooling. It is worth noting that the coefficient of Y, which gauges the income elasticity of such expenditure, exceeds unity by a significant amount. However, marked inelasticity of expenditure with respect to enrollment is also evident. The NL coefficient indicates that a 10 percent rise in the number of lower-level pupils would increase public outlays for such education by only four percent, which implies a reduction in average spending per pupil of more than five percent. When viewed in the context of the previous equation, this suggests that variation in outlays per pupil may serve to equilibrate the enrollment and expenditure functions (to the extent that the latter are autonomous rather than interdependent).

Foreign aid, as measured in this model, has no discernable effect on public spending for lower education; the negative coefficient is entirely without statistical significance. In contrast, the regional factor stands out sharply as a determinant. In the average African country (in the sample), XL is about double the amount expected on the basis of other variables in the equation; given the limitations of the data, this result should not be given a literal interpretation, but it seems clear that these countries allocate especially large shares of their resources to lower-level schooling.[28]

Turning now to higher education, the effects of past educational efforts are again highlighted. Although both S and XH are significant terms in equation 3.00, the former has much the larger beta coefficient, pointing to the dependence of higher education on the flow of students from the secondary schools. Enrollment is again inelastic with respect to spending; increases in outlays serve primarily to raise expenditure per student. For a cross-section spanning all degrees of development, the positive but insignificant coefficient of PH is not unexpected. In most countries, where relatively few persons study beyond the secondary level, other determinants greatly outweigh the demographic factor.

The equation explaining expenditure on higher education is subject to a considerable amount of multicollinearity. In its initial formulation (4.00), this is indicated by very high pair-wise correlations between NH and Y (r = .81), and NH and A (r = -.94), as well as by relatively large standard errors for all variables other than Y. As a first step, the equation is reformulated (as 4.01, with NH deleted), which costs nothing in explanatory power, and yields a more reliable set of coefficients.

In the results for 4.01, nearly all of the explained variance in XH may be attributed to international differences in per capita income. It will be noted, also, that the income elasticity of XH is significantly above unity, and by an even larger amount than shown for XL. Foreign aid may have a marginal influence: its coefficient is significant at the .10 level. This may reflect external financing of the education of students abroad and of the employment of expatriate faculty. The "African" regional factor apparently does not apply to higher education. It would seem that the African states concentrated their efforts at the lower level; however, the positive sign of A suggests that they had not done so at the expense of higher education, but instead had diverted resources from noneducational uses.

The determinants of educational effort--as gauged by this four-equation model--are remarkably uniform throughout the international cross-section. When the sample is partitioned into LDC and MDC subsets, and a common set of variables used (with F and A deleted), the Chow test shows an absence in all equations of significant differences (at the 10 percent level) between the regression populations.[29] In fact, however, the variables applicable to the two groups differ; also, as stated above, segmentation of the sample may be used to cope with possible multicollinearity. Accordingly, separate regressions for the LDCs and MDCs are presented in Tables 1-B and 1-C, and discussed below.

III. LDC - MDC Comparisons

For present purposes, the LDCs comprise 28 observations--the African, Asian, and Latin American nations in the sample (excluding Japan and Israel), plus Portugal and Malta; the MDCs consist of the remaining 16 nations. Most of the results for the separate segments are not greatly inferior, as indicated by variance explained, to those for the entire sample (with equations 3.20 and 4.20 as the main exceptions). This indicates that the observed relationships are not primarily "cluster effects" arising from gross differences between the MDCs and LDCs, and thus supports the inferences previously drawn.

The degree of economic development has a more noticeable affect on enrollment relationships than on expenditure patterns. Comparison of equations 1.10 and 1.20 reveals a discrepancy in the PL coefficients, and also sheds some light on the previously-discussed difficulties associated with this parameter. In the

MDCs, the PL coefficient is virtually equal to unity, as would be expected in advanced countries, where education is available to most of the school-age population. As the beta weights in equation 1.20 show, the relative size of this age group is the principal determinant of the population enrollment rate. In the LDCs, the PL coefficient displays the same degree of exaggeration as in the results for the entire 44-nation regression, although in the present case the difference from unity is not statistically significant. The overstatement is thus seen to be confined to the LDCs, indicating that the possible tendency to overestimate enrollment may be largely limited to those countries (and, among them, inversely related to the level of development).

In higher education, the enrollment patterns show the influence of differing levels of economic development in two respects. In the LDCs, the most important determinant is the lagged S variable, which reveals the constraining effects of a limited supply of secondary-school graduates. In the MDCs, S is not statistically significant, but PH is the most important determinant.[30] These results suggest that higher-education enrollments in the developed countries are typically limited by various forms of selectivity, rather than by the supply of secondary-school graduates; they indicate also that the size of the college-age population becomes a major factor only when enrollment rates in post-secondary education reach the relatively high levels prevailing in most of the MDCs.

The expenditure patterns for the LDCs and MDCs are generally similar at both educational levels. In the MDC subset, the lack of significance shown by endogenous NL in equation 2.20 is not readily explainable, but the occurence of a relatively large (and significant) coefficient for NH in 4.20 may be attributed to the absence of multicollinearity. In the LDC subgroup, however, the NH coefficient (in 4.10) is apparently distorted by multicollinear effects, requiring a respecification (4.11), with results closely resembling those obtained from the entire sample. It is noteworthy also that the "African" regional factor operates as a significant determinant of lower-level spending among the LDCs, and has virtually the same coefficient as in the 44-nation regression.

The effects of the youthful age structure that prevails in the LDCs as a whole may be readily, if roughly, traced through the equation system. If the PL coefficient is reduced by the amount of the standard error, to .95, then each 10 percent increase in that variable, within the LDC cross-section, raises enrollment by a virtually identical 9.5 percent. The enrollment rise is translated into a 4.7 percent gain in lower-level spending, which also may be interpreted as an addition to the share of GNP required for this purpose (not a trivial burden in poor countries). At the same time, average outlays per student, already very small because of low per capita income, would fall by 4.4 percent, with obvious implications for the quality of education. This outcome is consistent with the recently expressed concern regarding high drop-out and repeater rates, and other shortcomings in the schools of many LDCs.[31]

In general, the regression results for the LDCs are statistically superior to the results for the MDCs. The difference in the number of observations may be partly responsible, but it is also likely that autonomous factors, not represented in the model, play a larger role in the more affluent countries, where income constraints are much less severe and the consequences of past deficiencies in educational effort are no longer felt.

IV. Conclusions

Despite limitations imposed by the imprecision of the underlying data and other shortcomings of this study, certain implications of the foregoing analysis emerge in reasonably clear form:

1. The determinants of educational effort comprise a simultaneous system, but the spending-enrollment nexus is more tenuous than expected. Within the international cross-section, per capita income constitutes the main source of variation on the expenditure side, while the enrollment picture is dominated by demographic factors and by the persisting influence of past educational efforts.

2. Relatively large school-age populations, as such, do not seem to decrease the percentage of the age group actually enrolled. However, an age structure of this kind, which results mainly from

the maintainance of high fertility, entails other costs. Spending per pupil is reduced (probably with adverse effects on the quality of schooling) and the economic burden of education is increased.

3. In the LDCs, educational effort may be substantially restricted by the limited supply of secondary school graduates, which constrains both the number of potential teachers for the primary grades and the flow of prospective students toward higher education. There is, therefore, a strong recursive element in the educational problems of these countries, from which there may be no quick escape. To the extent that current per capita income reflects past educational efforts, recursiveness may be further reinforced.

4. Taken as a whole, the African states spent significantly more on lower-level schooling than did other nations, relative to per capita income and other determinants of such expenditures. This finding suggests the possibility that other low-income countries had some unused capacity to step up their educational outlays.

5. Foreign aid, in the period studied, made only a small and uncertain contribution to spending on higher education. Its effect at the lower educational levels does not approach the threshold of significance.

6. There is evidence of possible inflation in reported enrollment rates among the LDCs, suggesting that recent progress in this area may be in part illusory.[32] Overstatement aside,

enrollment gains may have been achieved at the cost of some dilution of the education process.

Footnotes

*The author is associate professor of economics at The University of Toledo and visiting research associate at the University of Michigan's Center for Research on Economic Development (CRED). He gratefully acknowledges the helpful comments received from Professor Elliot Berg, Peter Heller, and Peter Moock of CRED, and from Professor Ronald Lee, John Goodman, and Maury McDonald of the Seminar in Economic Demography at the University of Michigan.

[1]For surveys and samples of the vast literature accumulated on this subject, see: C. Arnold Anderson and Mary Jean Bowman (eds.), Education and Economic Development (Chicago: Aldine Publishing Co., 1965); Mark Blaug, An Introduction to the Economics of Education (London: The Penguin Press, 1970); E. A. G. Robinson and J. E. Vaizey (eds.), The Economics of Education (New York: St. Martin's Press, 1966); and UNESCO, Readings in the Economics of Education (Paris: UNESCO, 1968).

[2]Studies of this kind, often based on simple correlations between an index of the level of economic development (such as per capita income) and an education variable, may be by-products of investigations of the reverse relationship, i.e. the causal effects of education on development. These include the cross-sectional analyses made by Mary Jean Bowman and C. Arnold Anderson, "Concerning the Role of Education in Development," in UNESCO, pp. 113-129, and by Frederick and Charles A. Myers, Education,

Manpower and Economic Growth (New York: McGraw-Hill Book Co., 1964), Chapter 3. In a similar category is the time series study of M. C. Kaser, "Education and Economic Progress: Experience in Industrialized Market Economics," in Robinson and Veazey, pp. 89-173. Multiple regression analysis is employed by Daniel Blot and Michel Debeauvais, "Educational Expenditure in Developing Areas: Some Statistical Aspects," in Financing of Education for Economic Growth, ed. Lucille Reifman (Paris: OECD, 1966), pp. 73-83; Frederick Edding and Dieter Berstecher, International Developments of Educational Expenditure, 1950-1965 (Paris: UNESCO, 1969), pp. 69-75; and Hollis B. Chenery, Hazel Elkington, and Christopher Sims, A Uniform Analysis of Development Patterns (Cambridge: Center for International Affairs, Harvard University, July, 1970, mimeographed). These studies have in common the use of a very limited number of explanatory variables, as well as a single equation form.

[3]The primary source of current statistical information on international differences in various aspects of education is the UNESCO Statistical Yearbook (Paris: UNESCO, annual). Additional data and analyses, with special reference to the less-developed countries, are provided by the sources noted in footnote 1, as well as by Philip H. Coombs, The World Educational Crisis (New York: Oxford University Press, 1968); Gavin W. Jones, "Effect of Population Changes on the Attainment of Educational Goals in the Developing Countries," in Rapid Population Growth: Consequences

and Policy Implications, ed. Roger Revelle (Baltimore: Johns Hopkins Press, 1971), pp. 315-367; and World Bank, Education Sector Working Paper (Washington: World Bank, September, 1971).

[4]Translating these categories into the official UNESCO terminology, lower = first and second levels, and higher = third level. Both preschool and adult education programs are excluded. See UNESCO Statistical Yearbook. A further split, between the first and second levels, would be analytically useful, but would place even greater strain on the available supply of data, particularly in view of international differences in the relative length of the period of schooling at each level.

[5]It must be acknowledged that the underlying data leave much to be desired with respect to accuracy and comparability. On the shortcomings of educational statistics, see UNESCO, Statistical Yearbook. With regard to problems in population data, see United Nations, Demographic Yearbook (New York: United Nations, annual). Difficulties in the international comparison of income statistics have been widely discussed; a primary reference is Simon Kuznets, Problems in the Study of Economic Growth (New York: National Bureau of Economic Research, 1949), pp. 137-172. Manipulation of the data for use in the present study creates still another source of possible error.

The sample is comprised of the following countries, divided into LDC and MDC categories and listed thereunder in order of per capita income in 1965:

LDCs--Malawi, Ethiopia, Chad, Niger, Botswana, Pakistan, India, Togo, Malagasy Republic, Kenya, Cameroon, Korea, Swaziland, Syria, Liberia, Ecuador, Taiwan, Jordan, Columbia, Iraq, Guyana, Portugal, Chile, Mexico, Malta, Trinidad, Argentina, and Venezuela.

MDCs--Japan, Ireland, Italy, Israel, Netherlands, Finland, United Kingdom, Iceland, Norway, West Germany, Luxemburg, Denmark, Canada, Switzerland, Sweden, and United States.

[6]For evidence of such effects, see United Nations, The Determinants and Consequences of Population Trends (New York: United Nations, 1953), chs. V and VII.

[7]This exclusion also has the virtue of reducing interaction between per capita income and age structure. When included, the 0-4 population tends to reduce per capita income by adding to the dependency burden; at the same time, relatively low incomes are conducive to high fertility, and therefore to a large proportion of the population in this age bracket.

[8]Data used to derive this variable are taken from UNESCO, Statistical Yearbook. The total, rather than school-age, population is used as the denominator of this rate in order to preclude very high collinearity between NL and per capita income in the next equation.

[9]These are estimates based on data obtained from UNESCO, Statistical Yearbook, ibid. Expenditures both by central governments and by regional and local authorities are included.

[10]In 12 countries within the regression population for which appropriate data are available, the exclusion of privately-financed schooling understates total educational spending at all levels by an average of about 13 percent in 1965, or adjacent years. (Based on data shown in UNESCO, Statistical Yearbook, ibid.)

[11]This variable is based on data contained in United Nations, Demographic Yearbook. The time reference is to 1965, or to the nearest year for which data are available within the period 1962-1967. In some cases, interpolation is used to provide an estimate.

[12]The weights used are approximations of the relative enrollment rates, by age, for Mali in 1967 and are shown below:

Age	Weight
5-9	.47
10-14	1.00
15-19	.20

These weights are not untypical of many nations, both LDCs and MDCs, although the underlying enrollment rates are extremely variable. (See UNESCO, Statistical Yearbook for data on enrollment rates by year of age). Experimentation with other sets of weights, derived from data for several different countries, yielded essentially similar results.

[13]For discussion of demographic obstacles to the growth of education, see Gavin W. Jones and also the group of papers on "Demographic Aspects of Educational Development", in United

Nations, Proceedings of the World Population Conference, Belgrade, 30 August - 10 September 1965, Volume IV (New York: United Nations, 1971), pp. 135-189.

[14]See United Nations, The Determinants and Consequences of Population Trends, ch. VII.

[15]See UNESCO, Statistical Yearbook. In a comment on this paper, Elliot Berg offers the hypothesis that the supply may often be stretched by reductions in the educational standards for teachers, but this cannot be tested with presently available cross-sectional data.

[16]According to Coombs, expatriates comprised actual majorities of the secondary school teaching staffs in some African countries in the 1960s. pp. 40-41, 195. In an earlier version of the present model, a lagged higher-education enrollment variable was used as a proxy for the domestic supply of secondary-school instructors, but extremely high collinearity with S (a better estimator of NL) indicated that it should be omitted.

[17]Estimates of GNP per capita, at factor cost, are taken from International Bank for Reconstruction and Development, World Tables (Washington: IBRD, January, 1971, mimeographed).

[18]Data on the official flow of external aid in this period are provided by United Nations, Statistical Yearbook, 1967 (New York: United Nations, 1968).

[19]In addition, foreign aid may contribute to the growth of per capita income, but this relationship is not explicitly

incorporated into the model. For data on and discussion of external financing of education, see Coombs, pp. 149-156, 216; Richard Goode, "External Aid for Investment in Education," in OECD, pp. 41-56; H. M. Phillips, "International Aid for Educational Development in the Form of Technical Assistance and Real Resources," in Robinson and Vaizey, pp. 567-590; Hugh B. Ripman, "International Financing of Educational Investment," in ibid, pp. 591-599; and World Bank, pp. 14 ff.

[20]Extremely high collinearity with per capita income precludes the direct test of this relationship that might otherwise be made by appending endogenous XH to equation 2.00, and endogenous XL to equation 4.00.

[21]Based on data in UNESCO, Statistical Yearbook. Nationals studying abroad are included in the estimates for their own countries, wherever sizeable numbers are involved.

[22]UNESCO, ibid.

[23]United Nations, Demographic Yearbook. The use of a somewhat narrower age band would be desirable if the data permitted, but probably would not greatly affect the results.

[24]UNESCO, Statistical Yearbook.

[25]These include: in equation 1.00, between S and XL ($r = .74$) and PL and XL ($r = -.68$); in equation 2.00, between Y and F ($r = -.70$), Y and A ($r = -.69$), and NL and A ($r = -.67$); and in equation 3.00, between S and XH ($r = .76$).

[26]The exception is the F term in equation 2.00. Even here, a respecification in which F was omitted showed only the most trivial effects on the coefficients of the remaining variables.

[27]When neither an adjusted population denominator nor weighting is used, the coefficient is 1.55. The population adjustment alone brings this down to 1.47. Alternate sets of weights make little difference: e.g. with Canada weights, the coefficient is 1.39; with Taiwan weights, 1.27 (but some collinearity may have been present in the latter case).

Yet another possibility is the introduction of bias arising from the fact that both NL and PL have the same denominator, which is adjusted population. However, when NL is reformulated as enrollment relative to school-age populations, so that the NL denominator and PL numerator correspond, the latter has a positive sign (and is marginally significant) indicating that such bias is not present. In general, cross-sectional data reduce the possibility of bias arising from the use of such ratios. See Edwin Kuh and John R. Meyer, "Correlation and Regression Estimates when the Data are Ratios," Econometrica 23 (July 1955): 400-416.

[28]Computed thus: $100(e^{.687} - 1) = 97\%$, where the exponent is the A coefficient. Since this reflects, in part, the low enrollment rates characteristic of the African nations, an alternative computation, in which NL is omitted from the regression equation, may be of interest. Using the A coefficient resulting from the latter formulation yields a somewhat smaller "African" effect:

$100(e^{.438}-1) = 55\%$.

In a comment on this paper, Peter Moock suggests the possibility that the regional dummy is essentially a proxy for very low per capita incomes in the African states, combined with a politically-determined minimum level of educational expenditure. However, the nonlinear relationship that this implies is not supported by the regression results for the subsamples, which show similar Y coefficients, thus pointing to a linear function. (See below).

Just as enrollment apparently tends to be overstated, there may also be a degree of exaggeration in the expenditure figures for the African nations. In the latter case, however, there is no independent evidence that this has occurred.

[29]See Gregory C. Chow, "Tests of Equality between Sets of Coefficients in Two Linear Regressions," Econometrica 28 (July, 1960): 591-605.

[30]The negatively-signed PH coefficient for the LDCs (equation 3.10) is not significant. On the other hand, the positive PH coefficient in equation 3.20 is clearly "too large" by the amount it exceeds unity, but the excess is not statistically significant (at the 10 percent level).

[31]For discussion of qualitative problems in the educational systems of the LDCs, see Gavin W. Jones and World Bank.

[32]For a summary of these gains, see World Bank, ibid.

TABLE 1-A. REGRESSION RESULTS: FORTY-FOUR COUNTRIES, LDCs AND MDCs COMBINED
(TSLS estimators)

Eq.	D.V.	Const.	$\hat{XL}$	$\hat{NL}$	$\hat{XH}$	$\hat{NH}$	$\overline{PL}$	$\bar{S}$	$\bar{Y}$	$\bar{F}$	$\bar{A}$	$\overline{PH}$	$\bar{R}^2$ (F)
1.00	NL	2.726	.157[a]				1.334[a]	.199[a]					.865
			(.043)				(.171)	(.021)					(92.862)
			[.383]				[.608]	[.800]					
2.00	XL	-1.140		.407[b]					1.190[a]	-.005	.687[a]		.920
				(.168)					(.097)	(.027)	(.223)		(125.693)
				[.151]					[1.004]	[-.012]			
3.00	NH	-2.650			.300[a]			.479[a]				.919	.811
					(.119)			(.072)				(.965)	(62.673)
					[.281]			[.690]				[.070]	
4.00	XH	-1.811				.219			1.279[a]	.061	.649		.813
						(.288)			(.221)	(.049)	(.777)		(46.256)
						[.201]			[.946]	[.126]			
4.01	XH	-1.179							1.393[a]	.074[c]	.121		.810
									(.161)	(.046)	(.348)		(62.136)
									[1.031]	[.152]			

Notes: All variables, except $\bar{A}$, in logarithmic form. See text for definitions, and for composition of the regression population.

For each equation, regression coefficients are shown in the first row, standard errors in the second row (in parentheses), and beta coefficients in the third row [in brackets]. Significance levels, for one-tailed t-tests, are denoted "a" for the one percent level, "b" for five percent, and "c" for 10 percent.

TABLE 1-B. REGRESSION RESULTS: TWENTY-EIGHT LDCs

(TSLS estimators)

Eq.	D.V.	Const.	$\widehat{XL}$	$\widehat{NL}$	$\widehat{XH}$	$\widehat{NH}$	$\overline{PL}$	$\bar{S}$	$\bar{Y}$	$\bar{F}$	$\bar{A}$	$\overline{PH}$	$\bar{R}^2$ (F)
1.10	NL	2.298	.219[a] (.068) [.294]				1.319[a] (.368) [.257]	.190[a] (.026) [.666]					.862 (57.335)
2.10	XL	-1.373		.496[b] (.216) [.316]					1.090[a] (.179) [.871]	.011 (.046) [.023]	.678[b] (.280)		.768 (23.327)
3.10	NH	2.682			.459[a] (.180) [.293]			.484[a] (.082) [.704]				-1.196 (1.593) [-.069]	.798 (36.472)
4.10	XH	-1.378				.230 (.313) [.287]			1.207[a] (.290) [.778]	.046 (.071) [.078]	.608 (.861)		.640 (13.026)
4.11	XH	-.660							1.317[a] (.246) [.849]	.059 (.069) [.100]	.048 (.399)		.647 (17.523)

Notes: See Table 1-A.

TABLE 1-C. REGRESSION RESULTS: SIXTEEN MDCs
(TSLS estimators)

Eq.	D.V.	Const.	$\hat{XL}$	$\hat{NL}$	$\hat{XH}$	$\hat{NH}$	$\overline{PL}$	$\bar{S}$	$\bar{Y}$	$\overline{PH}$	$\bar{R}^2$ (F)
1.20	NL	4.696	.024 (.049) [.043]				1.061[a] (.101) [.922]	.172[a] (.049) [.308]			.884 (39.355)
2.20	XL	2.747		.094 (.346) [.046]					.992[a] (.149) [.880]		.739 (22.251)
3.20	NH	-4.843			.308[c] (.206) [.356]			.142 (.387) [.086]		2.641[b] (1.255) [.459]	.305 (3.697)
4.20	XH	-5.753				.729[b] (.379) [.376]			1.348[a] (.490) [.539]		.462 (7.449)

Notes: See Table 1-A.

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No. 13 ELLIOT J. BERG, *"Wages and Employment in Less-Developed Countries,"* December 1970. Republished in *The Challenge of Unemployment to Development and the Role of Training and Research Institutes of Development,* O.E.C.D. Paris, 1971

No. 14 THOMAS L. HUTCHESON and RICHARD C. PORTER, *"The Cost of Tying Aid: A Method and Some Colombian Estimates,"* January 1971. Republished in *Princeton Studies in International Finance,* No. 30, 1972

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