Educational Expenditures and School Enrollments In Less-Developed Countries: A Simultaneous-Equation Model

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Abstract

The purpose of this paper is to identify and measure the determinants of educational expenditure, enrollment, and outlays per pupil for a cross-section of LDCs (less developed countries) and to trace the interconnections among these variables. A simultaneous-equation model is developed, and then tested by two-stage least-squares regression procedures. In their structural form the regression results establish the statistical validity of the model; in their reduced form they gauge the full impact of each variable within the simultaneous system. The findings include specific estimates of the tradeoffs between enrollment and outlays per pupil at the various educational levels. It seems clear that the African nations tend to place major emphasis on primary education, the Asian countries on secondary schooling, and Latin America on higher education.

A large and growing body of economic literature is concerned with the quantitative and qualitative deficiencies of education in less-developed countries [e.g., Anderson and Bowman, 1965; Coombs and Hallak, 1972; Harbison and Myers, 1964; Robinson and Veazy, 1966; and UNESCO, 1968].[1] Little attention has been given, however, to the determinants of the amount of education actually provided, despite great variation among the LDCs in this respect. Such variations point to the need for, and the technical feasibility of, cross-sectional analysis.

Among the cross-sectional studies that have been made, some are based on simple correlations between an education variable (enrollment and expenditure) and an index of economic development, such as per capita income. [Bowman and Anderson, 1968; Harbison and Myers, 1964]. In others, multiple-regression equations are used, but the number of explanatory variables is extremely limited. [Blot and Debeauvais, 1966; Chenery, Elkington, and Sims, 1970; Edding and Berstecher, 1969]. In all cases, these models take the single-equation form, which means that total educational spending and enrollments are treated as unrelated phenomena. This separation is not only unrealistic, but also results in the neglect of the determinants of expenditure per pupil, a crucial dimension when viewed either as the unit cost

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[1]The listed references comprise only a small sample of a vast accumulation of literature on various aspects of this topic. For a partial bibliography, See Blaug [1970].

of schooling or as a rough index of educational quality.[2]

The present paper is an attempt to identify and measure--for a cross-section of LDCs--the determinants of educational expenditure, enrollments, and outlays per pupil, and to establish a systematic framework in which the interconnections among these variables may be analyzed. 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 formal model is presented in the first part of the paper. This is followed by an analysis of the statistical results of testing the model. The principal findings of the study are summarized in the final section.

I. The Model

The model represents an ex ante process of social decision-making involving three interrelated policy variables: (1) how many young people are to be schooled, (2) what amount of resources is to be allocated to their schooling, and, (3) how much is to be spent on each pupil. It is evident that each variable may be expressed as an exact function of the other two, and that taken together they comprise an indeterminate system. In order to ascertain the actual pattern of decision-making, the model is specified in determinate form, and tested by application to ex post data. The general form of this model is as follows:

$$N_i = f(X_i, W_i, \mu_n) \quad (1)$$

$$X_i = f(N_i, Z_i, \mu_x) \quad (2)$$

$$Q_i = X_i/N_i \quad (3)$$

The i subscript denotes countries, N represents enrollment, X is educational expenditure, Q symbolizes outlays per pupil, W and Z are intersecting sets of exogenous variables which explain variation in N and X, respectively, and μ is a stochastic error term.

The inclusion of X and N among the explanatory variables of the two stochastic equations expresses the simultaneity of their determination. Q, which is explained by an exact relationship with the other endogenous variables, is also implicitly present in the first two equations because of its effect on the coefficients of X and N.

Given the interdependent relationships postulated above, simultaneous equation methods are required for empirical testing of the model. For this purpose, two-stage least-squares (TSLS) regression procedures are appropriate, since the system is over-identified.[3] The model to be tested is also disaggregated by educational level: first (primary); second (secondary); and third (university and other post-secondary), in conformity with UNESCO definitions [UNESCO, 1967]. Explanatory patterns are expected to vary among levels, reflecting the distinctive characteristics of the subpopulations eligible for each kind of schooling, as well as other factors discussed below. Implicit allowance for the competitive and complementary relationships among different levels is made in the first stage of the estimating procedure, where each endogenous explanatory variable is regressed on all the predetermined variables in the model.[4]

The 30 observations of the regression population comprise all African, Latin American, and Asian countries (other than Japan and Israel) for which the required data are available.[5] The time reference is to the year 1965, except for the lagged variables described below. GNP, school expenditures, and foreign aid are measured in U.S. dollar equivalents. There exists a degree of incomparability, it should be noted, between the enrollment and expenditure variables arising from the nature of available data: the former refers to the number of students in public and private institutions, the latter to public expenditure at all governmental levels, including public subsidies to private schooling, but excluding purely private outlays. Fragmentary data suggest that this discrepancy is relatively unimportant.[6]

All variables, apart from the dummy designations of geographic region, are in logarithmic form, which improves the fit of most equations and has the added advantage that the coefficients directly measure elasticities. These variables are also on a per capita basis: they have as a common donominator the adult population (age 15 and over); this device facilitates both the interpretation of the coefficients and the subsequent computation of the reduced form of the model.[7] In order to simplify notation, the population denominator, the designation of logarithmic form, and the subscripts denoting countries have been deleted.

The disaggregated model consists of nine equations in all--six stochastic and three exact relationships. The equations and their constituent variables are briefly described below. The enrollment equations are presented first.

$$NF = a_0 + a_1 XF + a_2 PF + a_3 AFR + a_4 LAT + a_5 NSL + \mu_{nf} \quad (1.1)$$

$$NS = b_0 + b_1 XS + b_2 NFL + b_3 AFR + b_4 LAT + \mu_{ns} \quad (1.2)$$

$$NT = c_0 + c_1 XT + c_2 NSL + c_3 AFR + c_4 LAT + \mu_{nt} \quad (1.3)$$

$$0 < a_1, a_2, b_1, b_2, c_1, c_2, a_5 < 1$$

NF, NS, and NT refer to enrollment at the first, second, and third levels, respectively; XF, XS and XT are endogenous explanatory variables denoting recurring (noncapital) public expenditure at the corresponding levels; PF refers to the population in the first-level age group; NFL is enrollment in first-level schooling in 1960; NSL is second-level enrollment, similarly lagged; and AFR and LAT are regional dummy variables denoting sub-Saharan Africa and Latin America, respectively.[8]

The presumption that enrollment varies directly with expenditure needs no elaboration, but the expectation that the coefficients of the expenditure variables will be smaller than unity has a less-obvious basis: if both enrollments and the quality of education are perceived to be sub-optimal, additional resources will be used not only to provide more places in the school system, but also to remedy qualitative deficiencies by means of larger outlays per pupil.

[2]A recent study of methodological interest in this context utilizes a simultaneous-equation model to analyze the interaction of educational spending and enrollment within the United States. [Gustman and Pidot, 1973].

[3]For a non-technical discussion of this method, see Mason and Halter [1968]. For a more advanced treatment, in the context of the general problem of simultaneous-equation estimates, see Rao and Miller [1971, pp. 185-220].

[4]A conceptually superior method would have to append each endogenous expenditure variable to the other expenditure equations. In practice, however, this was precluded by a severe multicollinearity problem.

[5]The sample consists of the following countries, listed by region and thereunder in ascending order of per capita income in 1965:

Africa (sub Saharan). Malawi, Ethiopia, Niger, Botswana, Togo, Malagasy Republic, Sudan, Kenya, Cameroon, Swaziland, Ghana, Liberia, Senegal.

Asia (including Mideast). Pakistan, India, Korea, UAR, Syria, Taiwan, Jordan, Iraq.

Latin America. Ecuador, Columbia, Guyana, Surinam, Chile, Mexico, Trinidad, Argentina, Venezuela.

[6]This is but one of many problems relating to international comparisons of educational data. See UNESCO [1967 and later years] and Edding and Berstecher [1969, pp. 45-61].

[7]The presence of the same denominator on both sides of the regression equation introduces some possibility of bias in the coefficients. This risk is outweighed, however, where extreme values or heteroscadastic residuals cause difficulties, and is in any case minimized by the use of cross-sectional data. On the general nature of this problem, see Kuh and Meyer [1955].

[8]Enrollment and expenditure data are from UNESCO [1967 and subsequent years]. Ages 5-14 years, inclusive, are used to define the population in the first-level age brackets (which in fact vary among and within countries, but fall within this range). Population data are based on estimates by the United Nations [1969].

The second term in each equation is a proxy variable intended to gauge the size of the eligible subpopulation. At the first level, this is defined by the appropriate age brackets. For secondary schooling, the eligible group is represented by the number who, five years previously, were enrolled in the primary grades. Inasmuch as the prerequisite primary education is by no means universally available in the LDCs, this is believed to be more realistic than the more customary use of a set of age brackets.[9] On exactly the same principle, eligibility for higher education is gauged by lagged enrollment in secondary schools. It is further assumed that enrollment at each level is inelastic with respect to the corresponding eligibility variable, i.e. that the percentage of the subpopulation in school tends to vary inversely with the proportion of the total population in that group because of the increased difficulty of providing additional places in the educational system. [e.g., Jones, 1971, United Nations, 1971, pp. 135-189].

It will be noted that the first equation contains an "extra" term, lagged secondary-level enrollment, which appears here as a proxy for the potential supply of primary-school teachers. Instructors at the higher grades are more easily recruited from abroad and thus are less likely to form a bottleneck in expanding school systems.[10]

Inclusion of the regional dummy variables is based on the hypothesis that some nations enroll more (or fewer) students at a given educational level than the other observed determinants would indicate. When these nations comprise an identifiable subset, as in a regional grouping, the use of a variable designating their distinctive pattern of behavior is logically indicated. As it happens, the African and Latin American groupings have the largest numerical representation in the sample, but the regional effects associated with Asia (including the Mideast) may be readily inferred, since the latter is the sole residual category. Signs are not hypothesized for the geographic dummies.

The expenditure equations comprise the second major component of the model.

$$XF = d_0 + d_1 NF + d_2 Y + d_3 AFR + d_4 LAT + d_5 AID + \mu_{xf} \quad (2.1)$$

$$XS = e_0 + e_1 NS + e_2 Y + e_3 AFR + e_4 LAT + e_5 AID + \mu_{xs} \quad (2.2)$$

$$XT = f_0 + f_1 NT + f_2 Y + f_3 AFR + f_4 LAT + f_5 AID + \mu_{xt} \quad (2.3)$$

$$0 < d_1, e_1, f_1 < 1$$

$$d_2, e_2, f_2, d_5, e_5, f_5 > 0$$

Y is GNP at factor prices, AID represents the net official flow of external resources for the period 1962-65, and the other variables are as previously defined, except that enrollments now serve as endogenous explanatory variables.[11] (Prior stipulations regarding logarithmic form and the implicit population denominator continue to apply.)

The expected inelasticity of expenditure with respect to enrollment reflects the assumption that as enrollment rises, outlays per pupil decline, i.e., that there is a tradeoff imposed by the resource limitations of low-income countries. [Coombs, 1970]. With regard to Y, two assumptions are made: (1) that educational spending rises with per capita income and (2), more tentatively, that the income elasticity of such spending increases with educational level, which in turn presupposes the urgency of the social need for schooling to vary inversely with its level. Foreign aid may contribute to educational spending in any or all of three ways: (1) aid may be earmarked for educational purposes; (2) these funds 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 revenue from abroad.[12] Finally, as in the enrollment equations, regional variables are included, without specification as to sign, in order to test for the presence of geographic patterns.

The final component of the model is a set of exact relationships, which are stated in log linear form.

$$QF = XF - NF \quad (3.1)$$

$$QS = XS - NS \quad (3.2)$$

$$QT = XT - NT \quad (3.3)$$

QF, QS, and QT represent expenditures per student at the first, second and third levels of schooling, respectively, and the other variables are as previously defined.

As specified in the model, spending per pupil is determined by the net effects of total expenditure and enrollment, which are in turn subject to various exogenous and endogenous influences (including implicitly, Q itself). These effects will be gauged by substituting the expenditure and enrollment equations into the above formulation. Because of the hypothesized interaction among the endogenous variables, the reduced forms of the equations will be used for this purpose, in preference to the direct regression results. (See below.)

II. Regression Results

At this point it should be noted that the structural estimates of a simultaneous model can show only the direct effects of the explanatory variables on the dependent variables; indirect effects, which reflect interaction among the variables of the model, are not explicitly measured. [Goldberger, 1964, pp. 364-380.] Therefore, these estimates serve mainly to validate the hypothesized pattern of relationships. Accordingly, the primary emphasis at the present stage of the analysis is placed on the significance of the regression coefficients, rather than on their precise magnitudes.

The structural estimates produced by the two-stage least squares regressions are presented in Table 1. As the adjusted coefficients of determination show, the regressions attain very high levels of significance and explain from three-fifths to nine-tenths of the observed variance.[13] All six endogenous terms have positive coefficients that differ significantly from zero at the 10 percent level of probability; of these, four meet a one percent standard (based on a one-tailed t-test). Thus, the expectation of an independent system is essentially fulfilled. Further, the coefficients of the endogenous terms in all equations are less than unity, and, except for the NT coefficient, by a statistically significant margin (at the five percent level) supporting the initial assumption of an inelastic expenditure-enrollment relationship.

Among the exogenous variables, only AID was found to be statistically insignificant in all equations, and to be "incorrectly" signed in equation 2.2. With regard to regional factors, the dummy variables show the "African" effect to be stronger and more consistent than the "Latin American" influence: five AFR coeffi-

[9]The use of lower-level enrollment as a proxy for the subpopulation available for further schooling creates problems arising from inter-country variation in retardation and drop-out rates. The number of persons within the relevant age brackets who also had completed primary schooling would be a much better measure, but such information is not generally available. It should also be noted that a variable based simply on age brackets was found, in an earlier version of this model, to be without statistical significance.

[10]In the 1960's, the majority of secondary-school teachers in some African countries were expatriates. [Coombs, 1968, pp. 40-41, 195].

[11]Income data are from International Bank for Reconstruction and Development [January, 1971]. Foreign aid flows are derived from United Nations [1968].

[12]A number of writers have discussed the direct contribution of foreign assistance to education. [e.g., Coombs, 1968, pp. 149-156, 216; Phillips, 1966, pp. 567-590].

[13]The interpretation of R^2 in $TSLS$ estimation is subject to well-known reservations [Basman, 1962]. In the present case, however, these values conform fairly closely to the results of the corresponding ordinary least-squares equations.

TABLE 1.
Second-Stage Regression Results: Structural Estimates

Equation number	1.1	1.2	1.3	2.1	2.2	2.3
Dependent variable	*NF*	*NS*	*NT*	*XF*	*XS*	*XT*
Constant	-4.70	3.95	1.46	-.77	-2.10	-2.92
Endogenous variables						
XF	.34[a]					
	(.12)					
XS		.48[a]				
		(.15)				
XT			.55[a]			
			(.20)			
NF				.56[a]		
				(.17)		
NS					.45[b]	
					(.26)	
NT						.64[c]
						(.40)
Exogenous variables						
PF	.69[c]					
	(.51)					
NFL		.38[b]				
		(.17)				
NSL	.29[b]		.32[b]			
	(.12)		(.18)			
AFR	.18	-1.26[a]	-1.68[a]	.61[a]	.79[c]	1.37[c]
	(.30)	(.20)	(.33)	(.23)	(.47)	(1.00)
LAT	-.10	-.49[b]	-.94[a]	-.02	-.35	.63
	(.25)	(.21)	(.31)	(.30)	(.46)	(.74)
Y				1.19[a]	1.07[a]	.70[c]
				(.21)	(.35)	(.53)
AID				.05	-.01	.04
				(.06)	(.08)	(.10)
$\bar{R}^2$	.67	.86	.92	.82	.60	.59

Notes: All variables, except *AFR* and *LAT*, have adult population as their denominators, and are in logarithmic form. See text for definitions.
Standard errors shown beneath regression coefficients (in parentheses).
Significance levels denoted "a" for one percent, "b" for five percent, and "c" for 10 percent (based on one-tailed *t*-test).
$\bar{R}^2$ adjusted for degrees of freedom.

cients are statistically significant (at .10 or better), as against two *LAT* coefficients.

In the enrollment equations, the proxy variables representing the size of the eligible subpopulations are shown to be significant in all cases, although they are somewhat better predictors at the second and third levels than for the primary grades. However, lagged secondary enrollments are validated as a determinant of the amount of primary schooling. In the expenditure equations, the only consistently significant exogenous variable is per capita income, although its reliability tends to vary inversely with the level of schooling.

As previously stated, the structural estimates refer only to the direct relationships among the variables of the model. To gauge the full impact of each variable, it is necessary to derive the reduced form of the equation system. This is done by substituting the appropriate structural equation for each right-hand endogenous variable, and then solving for a new set of coefficients.[14] The derived reduced forms of the nine equations comprising the full model are shown in Table 2.

TABLE 2
Reduced-Form Equations

Equation number	1.10	1.20	1.30	2.10	2.20	2.30	3.10	3.20	3.30
Dependent variable	*NF*	*NS*	*NT*	*XF*	*XS*	*XT*	*QF*	*QS*	*QT*
Constant	-6.10	3.75	-.23	-4.19	-.41	-3.07	1.91	-4.16	-2.84
PF	.85			.48			-.37		
NSL	.36		.49	.20		.32	-.16		-.17
NFL		.48			.22			-.26	
Y	.50	.66	.59	1.46	1.37	1.08	.96	.71	.49
AID	.02	-.01	.03	.06	-.01	.06	.04	.00	.03
AFR	.48	-1.13	-1.43	.87	.29	.45	.39	1.42	1.85
LAT	-.13	-.84	-.92	-.09	-.73	.04	.04	.11	.96

Note: Derived from the structural estimates shown in Table 1.

The size of the *PF* coefficient in equation 1.10 is among the more striking results of the reduced-form computations, which show that a one percent increase in the population in the primary-school ages results in an almost equal percentage rise in enrollment. This is contrary to a priori expectations (which the structural estimates had tended to support). The *PF* coefficients elsewhere in the model explain this result. First, the elasticity of first-level expenditure with respect to *PF* is about .5, indicating that the allocation of public funds may be substantially influenced by the presence of relatively large numbers of school-age children. Second, the *PF* coefficient in the *QF* equation is -.37, which clearly suggests that, to a considerable extent, these children are accommodated in the primary schools by means of lower outlays per pupil.

Viewed in another way, the *PF* coefficients measure the incremental burden of the high birth rates prevailing in most LDCs, which produce the characteristically youthful age structure of their populations. In a "typical" country in the sample, a 10 percent decrease in the number of children age 5-14, relative to the number of adults, would simultaneously reduce public spending for primary education by about five percent, while raising average outlays per student by almost four percent. In low-income areas these are not trivial amounts.

At the second and third levels, the elasticity of enrollment with respect to *NFL* and *NSL* is only about .5, indicating that large eligible groups may in fact depress the proportions of these groups admitted to post-primary education. A major reason for this difference is suggested by the low elasticities of second and third level expenditures with respect to *NFL* and *NSL*–about .2 and .3, respectively. At these levels, the relatively small number of eligibles, combined with high unit costs (when compared with primary education), may dampen the positive response of the public authorities when it comes to allocating scarce resources. In addition, there may be a tendency for rates of completion to decline as enrollment rises; it will be recalled that *NFL* and *NSL* are proxy variables based on enrollment data, rather than direct counts of graduations. However, the *NFL* and *NSL* coefficients reveal a recursive feature of the model, i.e. the effects of past enrollment on the subsequent student population at the next higher level. At the primary

[14] The "derived-reduced form" equations should be distinguished from the "direct reduced-form" regressions which comprise the first stage of the two-stage least-squares regression procedure. [Goldberger, 1964, p. 365].

level, the recursive element refers to secondary education (believed to affect the supply of teachers at a later date.)

As would be expected, international differences in income per adult strongly influence educational spending. Contrary to expectations, however, the coefficients vary inversely with the level of schooling--ranging downward from almost 1.5 for the primary grades to approximately unity for higher education. The third subset of reduced-form equations indicates that these variations may be attributed mainly to the relationship between income and per pupil outlays. Within the *LDC* cross-section, the elasticity of the Q variable with respect to Y is about twice as great at the first level as at the third (with the second-level coefficient at about the midpoint). The model does not provide a direct explanation of this phenomenon. There may be an "irreducible" minimum of expenditure per student that varies directly with educational level; also, as Y rises (cross-sectionally), the distribution of public funds may increasingly favor the more deprived lower levels.

The regional variables in the reduced-form equations reveal that the African countries (in the sample) attain higher rates of educational expenditure--both total and per pupil, and at all levels--than do the other two regional groupings, when other determinants are held constant. Except for primary schooling, however, enrollment rates are lower in Africa than in the Latin American or Asian subsets. Low secondary and tertiary enrollments in the African states are clearly associated with relatively sizable outlays per pupil. Latin America (again generalizing from a subsample) appears at the other end of the scale, ranking below both Africa and Asia in first-level enrollment, and in total expenditures on primary and secondary schooling. Although exceeding the African enrollment rates at the second and third levels, Latin America falls well behind Asia in these respects. Only in outlays per student in higher education do the Latin-American countries surpass the Asian nations by an appreciable margin. In the Asian subset, second and third level enrollments tend to be substantially greater than in the other regions, and per pupil spending to be smaller, particularly in higher education.

Another way of viewing the regional differences is to compare the allocation of expenditures among educational levels, without regard to the amounts of such expenditure (once again, holding other factors constant). In these purely relative terms, it seems clear that the African nations tend to place major emphasis on primary education, the Asian countries on secondary schooling, and Latin America on higher education.[15]

Just as the reduced-form equations may be used to gauge the combined direct and indirect effects of changes in the exogenous variables, a comparable set of estimates may be derived for the endogenous variables. The coefficients of the constant terms of the equations, when substituted for the right-hand endogenous variables, show the impact of a given percentage change in any endogenous variable on related endogenous variables within the system.[16] From a policy perspective, the most meaningful of the endogenous interactions is that between the N and Q terms. The computed elasticities of outlay per pupil with respect to enrollment are as follows: *QF*, -.54; *QS*, -.70; and *QT*, -.55. Thus, a 10 percent increase in enrollment, within the cross-section, results in curtailed spending per pupil in the magnitude of five and one half to seven percent. To the extent that expenditure per pupil accurately gauges the quality of education, enrollment gains are purchased at the expense of very appreciable (if less than proportionate) reductions in quality and, similarly, qualitative improvement is strongly associated with curtailed enrollments. Given the budgetary constraints to which low-income countries are subject, this result is not surprising, although the magnitude may be greater than expected. It takes on particular significance, moreover, in the light of recent concern with the qualitative shortcomings of education in many LDCs. [Coombs and Hallak, 1974; Jones, 1971; World Bank, September 1971].

[15] Inasmuch as the African countries are clustered at the lower end of the distribution of per capita income within the regression population, and the Latin American nations at the higher end, the possibility arises that the regional variables may partly reflect nonlinearity in the expenditure or enrollment functions. However, when the sample is partitioned into two subsets and tested for homogeneity [Chow, 1960], no significant differences between the regression populations are found for any stochastic equation, supporting the initially hypothesized linearity and the straight-forward interpretation of the dummy variables.

[16] Take, for example, the reduced form of the *XF* equation (2.10), omitting the error term:

$$XF = \frac{d_0}{1 - d_1a_1} + \frac{d_1}{1 - d_1a_1}a_0 + \frac{d_1a_2}{1 - d_1a_1}PF + \frac{d_1a_5}{1 - d_1a_1}NSL + \frac{d_2}{1 - d_1a_1}Y + \frac{d_5}{1 - d_1a_1}AID + \frac{d_1a_3 + d_3}{1 - d_1a_1}AFR + \frac{d_1a_4 + d_4}{1 - d_1a_1}LAT$$

Here, a_0 is the constant of the enrollment equation that was substituted for the endogenous *NF* term of the original structural equation. The coefficient of this constant term in the reduced form, $d_1/1 - d_1a_1$, measures the elasticity of *XF* with respect to a shift in the *NF* function. (It will be recalled that the equations are in log linear form.) On the use of this technique, see Gregory, et al., [1972].

III. Conclusions

In their structural form, the regression results establish the statistical validity of the model and support the initial hypothesis that the decision-making process comprises a simultaneous system. In their reduced form, the results incorporate both the direct and indirect effects of the underlying determinants of this process and provide a substantial body of information on the specific parameters of the hypothesized system. This information, which has not previously been available, should have significant implications for the overall planning and evaluation of educational efforts in the LDCs. Its direct applicability remains subject, of course, to the limitations imposed by the size and composition of the sample, the time reference of the study, the recognized lack of precision in the underlying data, and by the well-known restrictions on generalizing from cross-sectional comparisons to intertemporal change. Within these limits, certain findings emerge from the analysis with sufficient clarity to warrant particular emphasis.

(1) A trade-off between enrollment and outlays per pupil operates at all educational levels: enrollment gains are financed to a substantial extent by decreased spending per pupil. Given the small amounts spent on the average student in most LDCs, this tradeoff suggests that large-scale expansion of enrollment may be very costly in qualitative terms (to the extent that per pupil outlays may serve as a valid, if highly approximate, index of educational quality.)

(2) Contrary to the customary view, relatively large populations in the primary-school ages exert no more than a slightly depressing effect on the proportion of the age group actually enrolled. In part, the absence of a strong negative impact may be traced to a tendency for countries to respond to the presence of large school-age populations with substantial increases in their education budgets. However, it also represents the trade-off syndrome noted above, i.e. expanding enrollments by spreading available funds more thinly among a greater number of pupils. Viewing the same relationships from another perspective, it appears that reduced birthrates, which would eventually diminish the proportions of young people in *LDC* populations, could provide an important educational benefit in the form of larger outlays per pupil, while at the same time lightening the fiscal burden of their schooling.

(3) The determination of expenditure and enrollment contains strong recursive elements. Income per adult emerges as the main contemporary influence on outlays for schooling, but current income may reasonably be presumed to

reflect, in part, past expenditures on education. Similarly, contemporary efforts to expand enrollment in the primary grades are constrained by prior scarcity of secondary schooling for potential teachers. The movement of students into secondary and higher education is inhibited by past limitations on the availability of prerequisite schooling at the lower levels. However, efforts to overcome these limitations may be vitiated by an inverse relationship between enrollment at a given level and the proportion of students who progress to the next level.

(4) Foreign aid inflows do not significantly affect either the quantity of resources allocated to education or its distribution among levels of schooling. However, the model does not take into account the possible indirect influence of such aid through its effects on aggregate income.

(5) National policies with respect to school expenditures and enrollment show strong conformity with broad regional patterns. Among these patterns the most striking is the propensity of the African states (taking the sub-sample as a whole) to spend appreciably more on education—at all levels—than do the other regional groupings, relative to income and other determinants. Although this finding suggests that other low-income countries have some unused capacity to step up their outlays for schooling, it does not warrant invidious comparison, given prevailing uncertainties with regard to optimal spending rates.

Regional differences are also evident in the relative distribution of resources among levels of schooling. When income and other determinants are held constant, it is clear that the African grouping tends to stress the first level, the Asian countries to emphasize secondary schooling, and Latin America to favor higher education.

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