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Economic Choices for Educational Policy in Africa

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Abstract

As elsewhere, in Sub-Saharan Africa, education contributes to economic growth. Yet as African countries confront recent low rates of economic growth, and as the social demand for education increases, policymakers must contend with the efficiency with which education is produced. In this paper, we provide a model for forecasting educational enrollments, educational costs, and a framework for the evaluation of the efficiency of educational services. This framework forms the basis for evaluating investment in education, against which claims on alternative investment resources should be judged. Empirical evidence suggests that reforming education in Africa is a necessary condition for sustained economic growth, given the rising claims of education on public sector budgets and the increasing difficulty that governments have in supporting existing and targeted enrollment levels. A revised version of this paper is found in *The Journal of African Finance and Economic Development* 1:1 (Spring 1992), pp. 135-164.

Economic Choices for Educational Policy in Africa

Introduction

In many countries in Africa today, formal education is in a state of crisis. While curricular reform continues to serve as an ongoing source of public policy debate, African leaders are confronting increasing difficulty in allocating educational resources to meet present and future levels of demand. The paralysis that has been unfolding is one characterized basically by education's rising claim on public sector resources against a backdrop of widespread poor economic growth, mounting international debt, and rapidly growing populations whose demand for education can not be met readily by traditional means. Figure 1 and Table 1 illustrate the positive relationship between per capita GDP and education's share of GDP. Wide disparities suggest that since education must compete against other claims for investment resources, how efficiently education is delivered may be as important as the level of resources. Within this context, we ask options are available to respond to Africa's growing educational demand, how can they be managed, and what role can these options play in promoting accelerated economic growth and development?

Figure 1

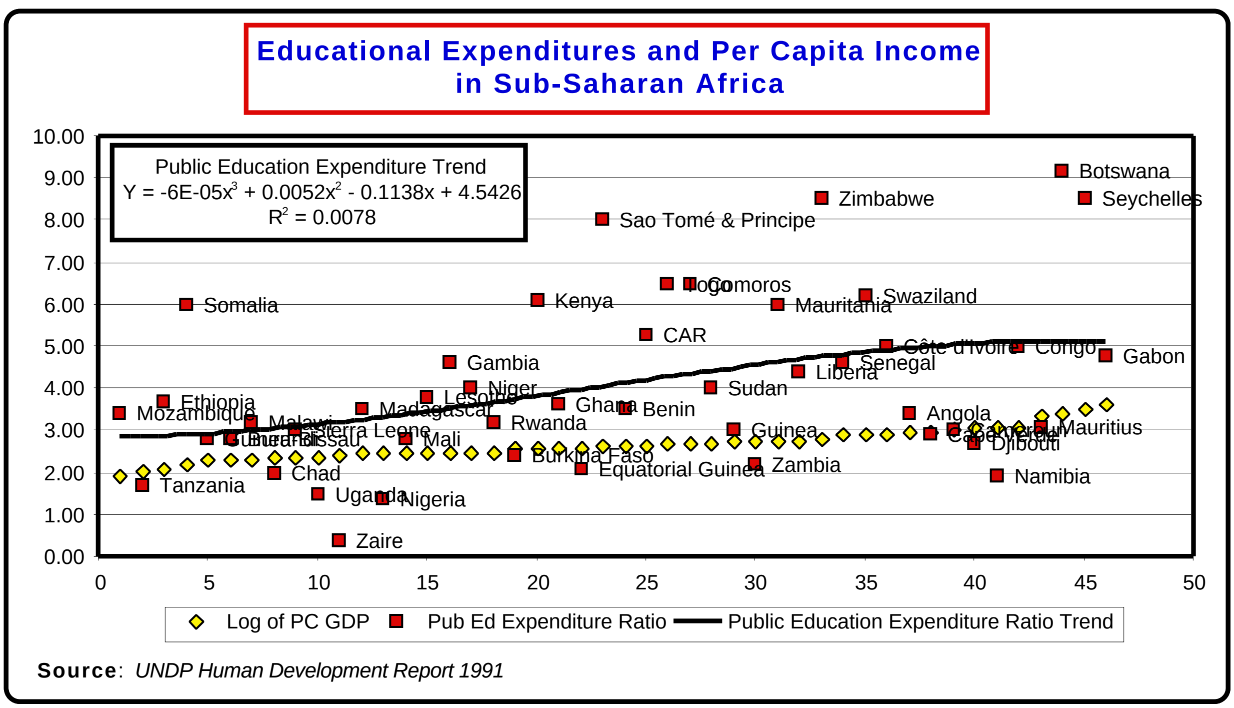


Table 1

Basic Correlations for Education in Sub-Saharan Africa

	A.	B.	C.	D.	E.
1990 PC GDP, in $U.S. *A.*	1.0000				
Adult Literacy Rate, 1989 *B.*	0.3645	1.0000			
Primary School Enrollment Ratio, 1988 *C.*	0.1882	0.6208	1.0000		
Secondary School Enrollment Ratio, 1988 *D.*	0.5320	0.5078	0.5757	1.0000	
Public Expenditure to GNP Ratio, 1986 *E.*	0.3777	0.0783	0.4093	0.4769	1.0000

African countries today face three basic policy options for education. One is to maintain existing institutions and programs and allocate relatively static levels of educational resources to an ever growing population. In time, this will most certainly reduce the effectiveness of the education received. It is a base case status quo option that few educational policymakers would willingly prefer, but one against which other options should be examined.

Another alternative is to increase the allocation of resources to education based on an expansion of existing institutions and programs, thereby preserving at least some of the quality of education received to growing populations. To do so requires either an improvement in the external economic environment which could expand the educational resource base, or a trade-off between the allocation of educational resources and other competing claims to those resources. While there are numerous ways in which the external resource environment could be improved, in the near term, such relief is not likely to take place in the absence of some form of domestic policy reforms, which brings us to the third option, namely, structural reform.

Structural reform in education is designed to improve the efficiency of services provided, and thus enable policymakers to respond to growing population demand even with a relatively limited educational resource base. Improving the efficiency of the allocation of resources to education implies several types of initiatives. Among them are curricular reform, improvements in the quality of educational inputs, decentralization of management, and a shifting of some of the financing burden away from the public to the private sector through programs of cost recovery.

While none of these choices is easy to implement, unless some steps are undertaken, many countries in Africa will simply experience serious declines in the quality of education, thereby undermining prospects for sustainable economic development. In the sections that follow, Africa's basic educational options are examined from an economic perspective. The approach presented here is to look first at Africa's institutional experience, then through use of an educational forecasting model, to consider the various alternatives that have ben proposed. What these alternatives imply in comparison to existing policy can then be more clearly understood.

Educational Achievement in Africa

In the nearly three decades since most African countries attained political independence from the major European colonial powers, education has been seen as playing a central role in promoting the social and economic development of the region. As the political transformation of Africa took place at the beginning of the 1960's, leaders of newly independent governments viewed colonial educational policies of the past as biased against economic development, especially given the relatively low levels of educational enrollments in most African countries at the time, and the relatively small numbers of secondary and higher education graduates that were being produced.

Expanding educational enrollments was seen as a logical instrument to overcome historically low levels of investment in education, as a means of providing a more productive labor force to compete in the world economy, and as a means of providing the necessary social and political leadership to assist in the building of modern societies. These goals, and the resources marshalled to meet them, were spelled out in periodic national and regional policy statements, through national development plans, and through annual budgetary decisions. What they shared in common was a goal of expanding the percentage of school-age children enrolled in schools, in expanding the production of secondary and higher education graduates, and in improving the level of educational qualifications of the active population.

Given Africa's historical legacy, most of the region's educational systems have been modeled largely on their European counterparts. Although African educational institutions have been modified partially to respond to local conditions, by and large, formal educational programs reflect the basic primary, secondary, and higher education structures and standards found in European countries. In practice, this has meant that for most African countries, educational policy and the allocation of resources to education has taken place essentially through the public sector rather than through the private sector, at the national level rather than at the local level, and frequently through the coordination of educational policy targets with national development planning of one form or another.

A standard operating assumption in many African countries has been that the setting of national educational policy reflects popular demand. Educational policymakers have thus viewed their role as seeking ways of meeting this social demand while matching the allocation of resources with the demand for educated labor in the economy in ways that are consistent with broadly based standards of social justice and economic efficiency. Since the reality of educational policy in Africa has been often far different from this stylized role, choosing efficient and equitable alternative policy options has not been a simple task.

By both historical and comparative standards, African countries have made remarkable progress in achieving the educational goals they have set for themselves. There are several ways of measuring this progress, but we will concentrate on two, namely, educational enrollment ratios, and on the level of education of the non-school population. Both measures show that almost without exception, African countries have made substantial gains since the early 1960's.

A country's educational enrollment ratio, or the percentage of the school-age population that is enrolled in school, has been one of the most applied standards of educational performance in Africa and in developing countries elsewhere. Between 1960 and 1984, the mean enrollment ratio of primary school-age children in 44 African countries rose from just over 40 percent to almost 80 percent. The mean enrollment ratio for the secondary school-age population in these same countries rose over the same period from 4 percent to over 21 percent, while the higher education enrollment ratio increased from 1.8 percent to just under 3 percent.

Given Africa's relatively high rates of population growth during this same period, these rates of expansion of enrollment ratios compare favorably with the historical experience of OECD, or Organisation of Economic Cooperation and Development, developed countries. Put somewhat differently, African countries accomplished comparable rates of expansion of educational enrollment ratios in a shorter time period than the historical experience of OECD countries when those countries had similar levels of educational enrollment ratios.

What makes Africa's record of educational enrollment expansion even more remarkable is the difference in its level of economic development in comparison to OECD countries. Although OECD countries had as of 1985 primary, secondary, and higher education enrollment ratios of 100, 90, and 31 percent, respectively, these ratios were reached over a longer time period, and with a relatively higher level of income than countries in Africa. While OECD countries comprised a population of over 740 million in 1986 in comparison to Africa's 537 million in 1986, OECD countries produced an aggregate Gross National Product of over $9.6 trillion dollars in comparison to Africa's $689 billion. In per capita terms, OECD per capita GNP stood at almost $13,000 in comparison to Africa's per capita GNP of $590, a ratio of over twenty to one.

Another way of measuring Africa's educational achievement is in terms of the level of schooling attained by various age groups in a given country. One benchmark is the percentage of each age-grouping of a country's population that has achieved some primary schooling. Among some 18 African countries for which census data are available, while less than ten percent of the population age 60 and above had received some level of primary schooling, almost 30 percent of the population between ages 15 and 19 had done so. Such increases in educational achievement across generations attests to the impact of rapidly expanding enrollment ratios among these countries.

Two patterns in Africa's educational enrollment experience are also worth noting. One is the change in the composition of enrollments over time. As total enrollments expanded during the decade from just under 50 million to over 90 million, the proportion of students enrolled at the primary level decreased from 85 to 80 percent, while the proportion of students enrolled in secondary and higher education increased from 14 to 19 percent and from 0.9 to 1.2 percent, respectively.

Another trend in Africa's educational record has been a tendency for inter-country differences in the composition of enrollments by level of schooling to diminish over time. As Africa's educational enrollments have expanded, countries that began with relatively low historical levels of primary education expanded their enrollment ratios faster than those that were at a higher relative level of enrollment. Based on a 21 country sample, for each percentage point lower of its 1960 population age 15-19 with primary education, a country tended to expand its primary educational enrollments by an annual rate of one-quarter of a percent more than for the group as a whole. Results of the simple regression used to estimate this relationship are given in equation 1.

(1.) Primary Enrollment Ratio = 10.5980 -0.259 (1960 Prim.Ed.Pop.)
(2.144)t(.025)

R^2 = .4632 residual variance = 22.0799

X	Y	
21.59	4.11	= Mean
16.38	4.20	= St. Dev. Sample
15.98	4.10	= St. Dev. Population

Education and Economic Growth

The willingness of African leaders to invest in education has been based on knowledge of education's role in the process of social and educational development. There is abundant evidence that education is a sound investment, whether undertaken in Africa or elsewhere. While there are many ways to assess the contribution of education to economic growth, two relatively simple ones at the macroeconomic level are the relationship between enrollment ratios and the level of GNP per capita, and the relationship between per student educational expenditures and per capita. At the microeconomic level, estimates of private and social rates of return to investment in education provide additional evidence of the economic productivity of education.

Based on a 1985-1986 sample of 35 African and OECD countries, a simple linear regression shows that each one unit increase in the primary enrollment ratio contributes approximately $21 dollars of additional GNP, results for which are summarized in equation 2. Comparable results hold for secondary and higher education. Similarly, using 1985 data for 35 African countries, a one unit increase in per capita expenditure on education resulted in an overall increase of $3.00 in per capita GNP, as summarized in equation 3.

(2.) GNP = -645.15 + 20.99(Primary Enrollment Ratio)
(2.046)$_{t(.025)}$

R^2 = .1885 residual variance = 20054110

X	Y	
73.09	889.43	= Mean
32.03	1548.76	= St. Dev. Sample
31.57	1526.47	= St. Dev. Population

(3.) Per Capita GNP$_{\$1985}$ = -11.7838 + 3.486(Per Student Public Expenditures)
(2.09)$_{t(.025)}$

R^2 = .3901 residual variance = 308314.6

X	Y	
177.63	607.43	= Mean
125.51	700.48	= St. Dev. Sample
123.70	690.40	= St. Dev. Population

While education contributes to higher levels of per capita income, it is far from the only factor. Yet, even if one examines the relative importance of education, there are wide variations in the contribution of education to economic growth among individual African countries. When one takes into account other factors, not all African countries are equally efficient in the production of education, nor do all types of education contribute equally to improvements in the level of income. For many countries in Africa, commitments to expanded educational opportunity made during the early 1960's were all too often embraced without careful consideration of the cost of education, of how efficiently or inefficiently educated graduates were being produced, and whether the system was operating in ways that were consistent with social justice. The result has been than for many African countries, the traditional ways of supporting educational expansion are no longer adequate.

Despite the European legacy to African education, there are some important differences that have evolved with regard to how education is financed, and how efficiently it has been produced. Consider, for example, the share of GNP that is devoted to education. Despite substantial progress, African countries as a whole still tend to spend a smaller share of their Gross National Product on education than do OECD countries. For example, between 1975 and 1985, the share of GNP devoted to education among 41 African countries averaged under 5 percent, while for the 21 countries of OECD, education's share of GNP represented almost 6 percent. The reason for this disparity can be traced directly to differences in how education is financed.

For most African countries, education at all levels has ben provided largely at only nominal direct cost to students. Governments have assumed most of the educational financing burden, relying on taxation and international assistance to meet specific educational goals. Moreover, public education institutions have accounted for a higher share of educational enrollments at all levels than among OECD countries, although these differences are less pronounced when comparisons are made between European and African countries.

African countries have also regularly apportioned a higher percentage of public expenditures to education than have OECD countries. Given Africa's relatively poor economic growth during the last decade, as public sector budget deficits have grown, and international debt has mushroomed, the scope for traditional public support of education has diminished considerably. It is precisely the relatively weak level of fiscal performance in African countries coupled with relatively poor economic growth that has given rise to pressures for reform of the public sector in general.

Alternative Educational Policies

A useful way of looking at Africa's educational policy alternatives is in terms of a basic forecasting model. At the core is an educational production function relating inputs and outputs based on linear relationships. Empirical evidence suggests that for any educational cycle, repeater, promotion, dropout, and graduation rates are relatively stable over time. This permits one to construct an educational flows matrix that can be used to generate forecasts of enrollments by grade, and to predict the number of graduates and dropouts over time. In turn, if educational inputs are relatively constant, then one can also determine the required number of teachers by level of qualification, the required number of classrooms and laboratories, as well as the required level of material and administrative inputs to sustain a given level of enrollments. If input prices are also known, then one has a basis for projecting the budgetary cost of any given enrollment target, as well as to evaluate fundamental policy alternatives using established economic investment criteria.

To illustrate how such a model can be used, let us consider a hypothetical educational cycle of three years' duration. An educational flows matrix, A, contains repeater rates along the principal diagonal, with promotion rates along the first inferior diagonal. Post-multiplying the flows matrix by a column vector of student enrollments, S_0, generates the level of enrollments by grade within the cycle for the next academic year, or time period, S_1. By adding a row vector for the graduation rate, G, one can also predict the number of graduates, and by adding a row vector for the dropout rate, D, one can also predict the number of dropouts from all three grades of the cycle from one year to the next. Recursively post-multiplying each year's column vector of student enrollments by the educational flows matrix generates outputs for the forecasting horizon. Since students either repeat, dropout, or are promoted, the allocation coefficients of each column of the augmented student flows matrix sum to unity.

Generating student cohort flows permits one to derive student flows accounting measures which are used to determine the technical, or pedagogical, efficiency of the education system. To measure pedagogical efficiency, several indices are used. First, one needs to calculate the total number of pupil-places provided for all students of the cohort to pass through the system. Second, one needs to calculate the number of pupil-places provided for students who eventually graduate. This is the total number of pupil-places minus the cumulative number of dropouts. Third, one calculates the number of students who eventually graduate, and finally, one calculates the weighted average number of years it takes to produce a graduate.

Table 2 provides a simplified numerical example of a three-year system. For the first year, the repeater rate is zero, the promotion rate is 80 percent, and the dropout rate is 20 percent. If we take an initial cohort of 100 students, the recursive matrix products generate all flows through the system until no more students are enrolled.

Table 2

Disaggregated Educational Forecasting Model

Pedagogical Efficiency Profile

Predicted Educational Outputs:

System: **Base Case** Year:

Educational Flow Matrix:				1		2	3	4	5	6	7	8
E-1	E-2	E-3										
.00			E-1	100	=	0	0	0	0	0	0	0
.80	.10		E-2	0	=	80	8	1	0	0	0	0
	.75	.10	E-3	0	=	0	60	12	2	0	0	0
		.50	Graduates		=	0	0	30	6	1	0	0
.20	.15	.40	Dropouts		=	20	12	25	5	1	0	0
Yearly Enrollment:				100		80	68	13	2	0	0	0

A. **Educational Flows Matrix Accounting Identities**:

1. Pupil-Places: 263.00 = Number of Pupil-places provided for through-put of total student cohort. (cumulative yearly enrollments)
2. Graduate Pupil-Places: 200.00 = Number of Pupil-Places provided for all students who eventually graduate from the original cohort (cumulative yearly enrollments minus cumulative dropouts)
3. Graduates: 37.04 = Number of students from original cohort who eventually graduate
4. Average Graduation Years:3.22= Weighted average number of years to produce one graduate

B. **Pedagogical Efficiency**:

1. Gross: 37.04 Percent = Graduates divided by initial student cohort
2. Graduate: 18.52 Percent = Ratio of cohort graduates to number of graduate-producing pupil-places. (pupil-places minus cumulative dropouts)
3. Net: 14.08 Percent = Graduates divided by the number of total pupil-places.

Pedagogical efficiency of the system can be derived from student flows accounting. The simplest measure is the percentage of an original cohort that eventually graduates from the system, or the gross pedagogical efficiency. Although this is a commonly used yardstick, it does not take into account the length of time that it takes to produce a graduate nor the number of places required to do so. It is downward biased as tool for evaluating educational costs.

A more precise alternative is to define pedagogical efficiency as the ratio of graduates to the number of graduate-producing pupil-places, which is referred to here as graduate pedagogical efficiency. This is a much smaller ratio than gross pedagogical efficiency, but it takes into account the number of pupil-places needed to produce a graduate from the system over time.

Although one could also include those pupil-places for students who drop out of the system to derive a measure of net pedagogical efficiency, if policymakers are interested in evaluating the cost of producing a graduate from an educational cycle, it is more a appropriate to include only the number of places that eventually produce graduates from the system. For our present purposes, graduate pedagogical efficiency will therefore be used in evaluating alternative educational policy choices.

How would the three measures of efficiency compare under an ideal educational cycle? Under an ideal system, there would be a 100 percent promotion and graduation rate, in which case the repeater and dropout rates fall to zero. Gross pedagogical efficiency would then be 100 percent. However, graduate and net pedagogical efficiency would only be 33 percent since it would still take three years to produce a graduate. One could derive compensated graduate and net pedagogical efficiency measures by multiplying each efficiency ratio by the theoretical number of years needed to complete the cycle, in which case all three measures would then be equivalent at 100 percent. Because we are interested in assessing the impact of educational reform on enrollments, educational budgets, and on the economic efficiency of investment in education, it is the uncompensated measures that are more useful for policy purposes. The advantage of the uncompensated graduate and net pedagogical efficiency ratios is that they can be more readily used in deriving the unit graduation cost, which in turn can be used to estimate the rate of return to investment in the educational cycle.

Under an ideal education cycle, the cost of producing a graduate is the annual enrollment cost multiplied by the theoretical number of years. In other cases, such as the system portrayed in Table 2, one must multiply the annual enrollment cost by a cost adjustment factor to reflect the pedagogical inefficiency of the system. Using the framework of Table 2, the total graduate cost adjustment factor is defined as the ratio of graduate pupil-places to the number of graduates, which in this case is equal to 200 divided 37.04, or 5.4. Next, by dividing the graduate cost adjustment factor by the average number of years needed to produce one graduate, which in this case is 5.4 divided by 3.22, one has an estimate of the annual graduate unit cost adjustment factor, or 1.68.

Multiplying each year, or fraction thereof, that a student is enrolled on the average to graduate by the annual graduate unit cost adjustment factor yields the annualized graduate unit cost adjustment factor. Finally, multiplying the annualized graduate unit cost adjustment factor by the annual enrollment cost yields the annualized graduate enrollment cost of the system. The annualized graduate unit enrollment cost of the system can then be used with an estimate of the benefit stream to evaluate the economic value of investment in the particular educational cycle.

Table 3 shows the steps used in calculating the cost of producing a graduate from the system and how these costs are converted into an investment evaluation stream. The example used here is the base case of Table 2.

Traditionally, evaluating the cost of producing a graduate from a system has been based on multiplying the annual enrollment cost by the average number of years required to produce a graduate. In the preceding case it would be calculated as the product of 1751 times 3.22, or $5638. Yet because dropouts have also been produced, the cost of a graduate exceeds $5638. One needs to adjust upward the cost of producing a graduate beyond the average time it takes for a student to graduate. In our present example, instead of $5638 per graduating student, the adjusted graduate cost is the sum of the annualized adjusted unit enrollment costs in row E, or $9474.

Table 3

Disaggregated Educational Forecasting Model
Economic Evaluation Tableau

System: **Base Case**

1. Graduate Pupil-Places:	200.00
2. Graduates:	37.04
3. Average Years to Graduate:	3.22
4. Total Graduate Cost Adjustment Factor:	5.40
5. Annual Graduate Unit Cost Adj. Factor:	1.68
6. Annual Enrollment Cost:	1751.00

Year:	1	2	3	4	5	6	7	8
A. Annual Enrollment Cost	1751	1751	1751	1751	1751	1751	1751	1751
B. Ith Enrollment Year:	1	1	1	.22	0	0	0	0

C. Ann. Gr. U. C. A. Factor	1.68	1.68	1.68	1.68	0	0	0	0
D. Ann. Gr. E. C. Factor	1.68	1.68	1.68	.37	0	0	0	0
E. Annual Grad.Enroll.Cost	2942	2942	2942	648	0	0	0	0
F. Annual Benefits:	0	0	0	1200	2000	5200	6300	7000
G. Undisc. Net Benefits:	-2942	-2942	-2942	552	2000	5200	6300	7000

H. Investment Criteria:

1. Internal/Social Rate of Return: 20 percent
2. Net Present Value: 0 percent
3. Benefit-Cost Ratio: 1 percent

1. Internal/Social Rate of Return: 20 percent
2. Net Present Value: 0 percent
3. Benefit-Cost Ratio: 1 percent

From the adjusted estimate of annual graduating student unit costs, one can then proceed to evaluate the private and social rate of return to investment in a given educational cycle. Row F of Table 3 provides a hypothetical incremental benefits stream from investment in the given educational cycle. Depending on whether one has estimated only the private costs benefits or the social costs and benefits, one can then derive the internal or social rate of return to investment in the educational cycle, which in turn can be used to derive the Net Present Value and corresponding Benefit-Cost ratio.

Thus far we have only shown how an educational flows matrix can be used to measure the pedagogical efficiency of a system. We have done so by limiting intake to an initial year and tracing the flows of students through the system. However, the student flows model can also be used to predict enrollments based on new student intake each year.

A simple way of converting the student flows matrix into a forecasting model is to convert the a_{11} cell into a compound growth expression, which can then serve as an instrumental policy variable. The compound growth expression embodies both the underlying repeater rate plus an expansion rate of first-year enrollments from one year to the next.

In Table 4, the first grade expansion rate has been set at zero, and with enrollments initially of 250, 100, and 75 students in each grade, eventually a steady-state enrollment profile emerges from the recursive matrix products. Obviously, the more elongated the production cycle, the longer it takes for a steady-state pattern to emerge from a zero expansion rate.

Table 4

Disaggregated Educational Forecasting Model

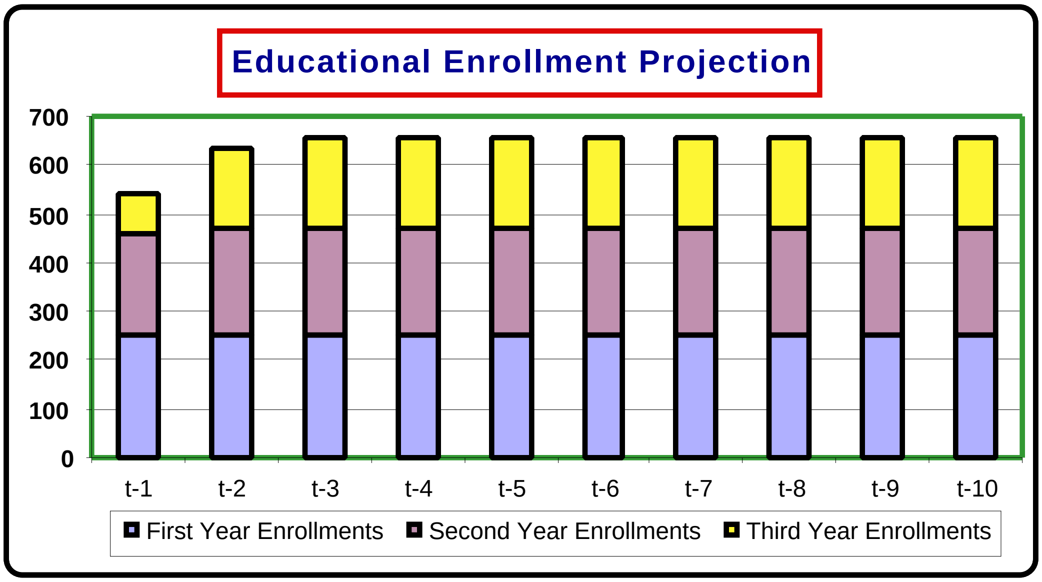
Steady-State Enrollment Pattern

Predicted Educational Outputs:

System: **Base Case** Year:

Educational Flow Matrix:					1		2	3	4	5	6	7	8
E-1	E-2	E-3											
1.00				E-1	250	=	250	250	250	250	250	250	250
.80	.10			E-2	100	=	210	221	222	222	222	222	222
	.75	.10		E-3	75	=	83	166	182	185	185	185	185
		.50	Graduates			=	38	41	83	91	92	93	93
.20	.15	.40	Dropouts			=	95	115	149	156	157	157	157
	Yearly Enrollment:				425		543	637	654	657	657	657	657

Figure 1



Since cell a_{11} is now a compound growth rate expression, switching from the steady-state enrollment system to an expanding system is relatively simple. Given that educational policymakers base many of their enrollment targets on terminal period enrollment ratios, if we know the initial stock of the educable cohort population and if we know at what rate the educable cohort population is expanding, we can iteratively choose alternative first-grade expansion rates to achieve a desired terminal period enrollment ratio. For example, if the initial educable cohort population is 2000, our initial three-year cycle enrollment ratio is 543/2000, or 21 percent. If the educable cohort population is expanding by 2.5 percent a year, in order to achieve a 50 percent enrollment ratio by year 8, we will have to expand first-grade enrollments by 10 percent a year.

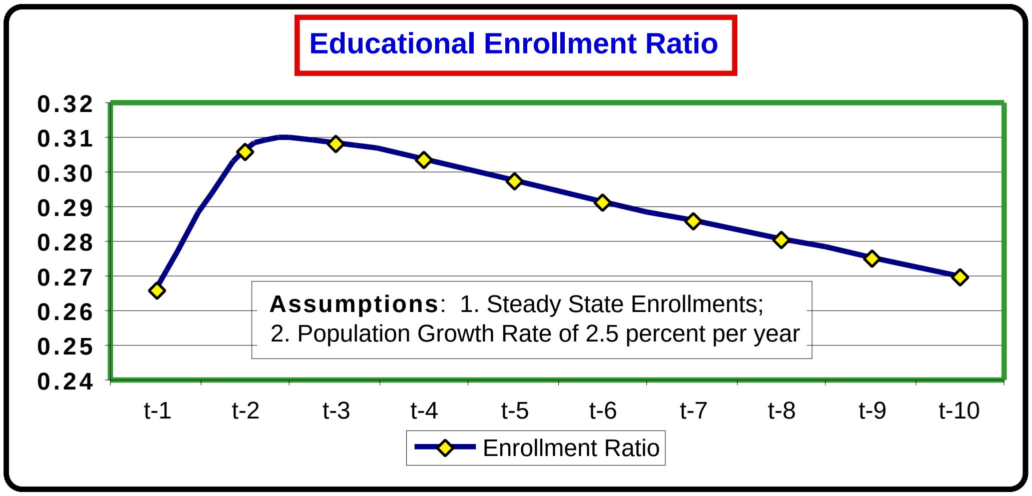
A comparison of enrollments and enrollment ratios under alternative first-grade expansion rates based on our hypothetical educable cohort population is summarized in Table 5.

Table 5

Annualized Enrollment Ratio Projections

System: **Base Case**	Year 1	2	3	4	5	6	7	8
Educable Cohort (expansion = 2.5%)	2000	2050	2101	2144	2208	2263	2319	
Total Enrollment at:								
a. 0 Percent	425	543	637	654	657	657	657	657
b. 5 Percent	425	555	672	723	761	800	840	882
c. 10 Percent	425	568	709	796	878	966	1063	1169
Enrollment Ratios at:								
a. 0 Percent	.21	.26	.30	.30	.29	.28	.28	.27
b. 5 Percent	.21	.27	.32	.34	.35	.36	.37	.38
c. 10 Percent	.21	.28	.34	.37	.40	.43	.46	.49

Figure 2



While targeting planning horizon enrollment ratios has functioned as a traditional tool of educational policy in many African countries, it is inadequate as a guide to the efficient allocation of investment resources and in many cases it is also at odds with prevailing standards of social justice. What is needed is to link the enrollment ratio targeting framework to the economic environment. To do so, one must link pedagogical productivity to the economic costs and benefits of producing educated graduates from a given educational system.

A simple way of linking pedagogical productivity to the economic consequences of education is to calculate the costs of producing a graduate from a given education cycle in comparison to the projected stream of benefits, as has been outlined in Table 3. In terms of costs, if input requirements per student are relatively constant, one can then construct column vectors of teacher, administrative, material, classroom, and laboratory input coefficients which can then be recursively post-multiplied by the unit value of total predicted enrollments for each year. In turn, if the unit cost of each of these variables is known and given, one can then project the required budgetary level necessary to sustain a given level of projected enrollments by multiplying the vector of unit costs times the vector of required inputs.

Table 5 illustrates how the disaggregated forecasting model can be used to link enrollment ratio targets to budgetary projections. If budgetary constraints are known, one has an initial basis from which to assess the financial feasibility of achieving a given terminal year enrollment ratio target. The hypothetical input coefficients and input prices in Table 6 are designed to shown on the basis of a 5 percent first-year growth rate of enrollments what the required total budgetary expenditure will be to sustain enrollments for each of the projected 8 years. In this particular case, input coefficients and input prices are assumed initially to be invariant with respect to time and the level of enrollments, although the system could also be modified to account for changes in input coefficients and input prices over time as a function of the particular rate of expansion.

Given the underlying pedagogical efficiency of the student flows matrix, the educational cycle will generate for differing rates of first-grade expansion variable proportions of graduates and dropouts for each and every time period. Thus, not only can policymakers identify the budgetary consequences of a given rate of expansion, they can also utilize the enrollment and budgetary projections to estimate the flow of graduates and dropouts to the labor market, and to assess the impact of these flows on estimated economic returns. While it is not illustrated here, linking the production of educated outputs to the labor market also requires that one join all education systems within a given hierarchy so that net educated output projections are based only on non-continuing student flows. Specification of multi-level educational forecasting also enables policymakers to derive the aggregate budgetary consequences of differential rates of expansion among alternative levels of the economy's education system.

Table 6

Disaggregated Educational Forecasting Model
5 Percent First Year Growth Rate

					Predicted Educational Outputs and Inputs:						
System: **Base Case**				Year:							
Educational Flow Matrix:				1	2	3	4	5	6	7	8
E-1	E-2	E-3									
1.05			E-1	250	263	276	289	304	319	335	352
.80	.10		E-2	100	210	231	244	256	269	282	296
	.75	.10	E-3	75	83	166	190	202	212	223	234
		.50	Graduates:		38	41	83	95	101	106	111
.20	.15	.40	Dropouts:		95	117	156	170	180	189	198
			Yearly Enrollment:	425	555	672	723	761	800	840	882

Educable Cohort Projection:

Base Year Cohort:	2000							
Educable Cohort Growth Rate:	2.5%							
Projected Education Cohort:		2050	2101	2154	2208	2263	2319	2377
Projected Enrollment Ratio:	.21	.27	.32	.34	.34	.35	.36	.37

Required Educational Inputs:

Teacher I-O Required

Coefficients:		Teachers:								
P-A	.006185	Professor	2.63	3.43	4.16	4.47	4.71	4.95	5.19	5.45
P-B	.005739	Ass.Prof.	2.44	3.19	3.86	4.15	4.37	4.59	4.82	5.06
P-C	.010237	Asst.Prof.	4.35	5.68	6.88	7.40	7.79	8.19	8.60	9.03
P-D	.015028	Instructor	6.39	8.34	10.10	10.86	11.44	12.02	12.62	13.25
		Total Teachers:	15.81	20.64	25.00	26.88	28.32	29.75	31.23	32.80
		Student/Teacher Ratio:	26.89	26.89	26.89	26.89	26.89	26.89	26.89	26.89

Administrative I-O Coefficients:		Required Personnel:								
A-1	.006	Central	2.55	3.33	4.03	4.34	4.57	4.80	5.04	5.29
A-2	.002	Technical	.85	1.11	1.34	1.45	1.52	1.60	1.68	1.76
A-3	.0045	Clerical	1.91	2.50	3.03	3.25	3.43	3.60	3.78	3.97
A-4	.0012	Maintenance	.51	.67	.81	.87	.91	.96	1.01	1.06
		Total Administration:	5.82	7.60	9.21	9.90	10.43	10.96	11.51	12.08
		Student/Administrative Ratio:	72.99	72.99	72.99	72.99	72.99	72.99	72.99	72.99

Materiel I-O Coefficients:		Required Materiel:								
M-1	.00025	Equipment	.11	.14	.17	.18	.19	.20	.21	.22
M-2	.00017	Supplies	.07	.09	.11	.12	.13	.14	.14	.15
M-3	.00004	Repairs	.02	.02	.03	.03	.03	.03	.03	.04

Classroom Space Coefficients:		Space Required:								
	.037189	Lecture	15.81	20.64	25.00	26.88	28.32	29.75	31.23	32.80
	.0037189	Labs	1.58	2.06	2.50	2.69	2.83	2.97	3.12	3.28

Financial Projections:

Teacher Inputs:	$Dollars								
P-A	$38000	1.0e5	1.3e5	1.6e5	1.7e5	1.8e5	1.9e5	2.0e5	2.1e5
P-B	$34000	8.3e4	1.1e5	1.3e5	1.4e5	1.5e5	1.6e5	1.6e5	1.7e5
P-C	$29000	1.3e5	1.6e5	2.0e5	2.1e5	2.3e5	2.4e5	2.5e5	2.6e5
P-D	$23000	1.5e5	1.9e5	2.3e5	2.5e5	2.6e5	2.8e5	2.9e5	3.0e5
	Totals:	$4.6e5	6.0e5	7.2e5	7.8e5	8.2e5	8.6e5	9.0e5	9.5e5

Administrative Inputs:									
A-1	$40000	1.0e5	1.3e5	1.6e5	1.7e5	1.8e5	1.9e5	2.0e5	2.1e5

A-2	28000	23800	3.14e4	3.8e4	4.0e4	4.3e4	4.5e4	4.7e4	4.9e4
A-3	21000	20163	5.2e4	6.4e4	6.8e4	7.2e4	7.6e4	7.9e4	8.3e4
A-4	15000	7650	1.0e4	1.2e4	1.3e4	1.4e4	1.4e4	1.5e4	1.6e4
Total Administration:		$1.7e5	2.3e5	2.7e5	3.0e5	3.1e5	3.3e5	3.4e5	3.6e5

Materiel Expenditures:

M-1	$35000	3719	4856	5883	6325	6663	6999	7349	7716
M-2	30000	2168	2831	3429	3686	3883	4079	4283	4498
M-3	70000	1190	1554	1883	2024	2132	2240	2352	2469
Total Materiel:		$7.1e3	9.2e3	1.1e4	1.2e4	1.3e4	1.3e4	1.4e4	1.5e4

Classroom Variables:
Interest Rate: 10 Percent
Maturity: 25 Years
Capital Cost:
Per Student Place: $1500
Total Cost: $40335 per Class
Unit PMT: $4444 per Class

Total Unit Payment:	$7.0e4	9.2e4	1.1e5	1.2e5	1.3e5	1.3e5	1.4e5	1.5e5

Laboratory Variables:
Interest Rate 10 Percent
Maturity 25 Percent
Capital Cost:
Per Student Place: $8000
Total Cost: $215117 per Laboratory
Unit PMT: $23699 per Laboratory

Total Unit Payment:	$37457	489155925963706	67109	70494	74022	77723

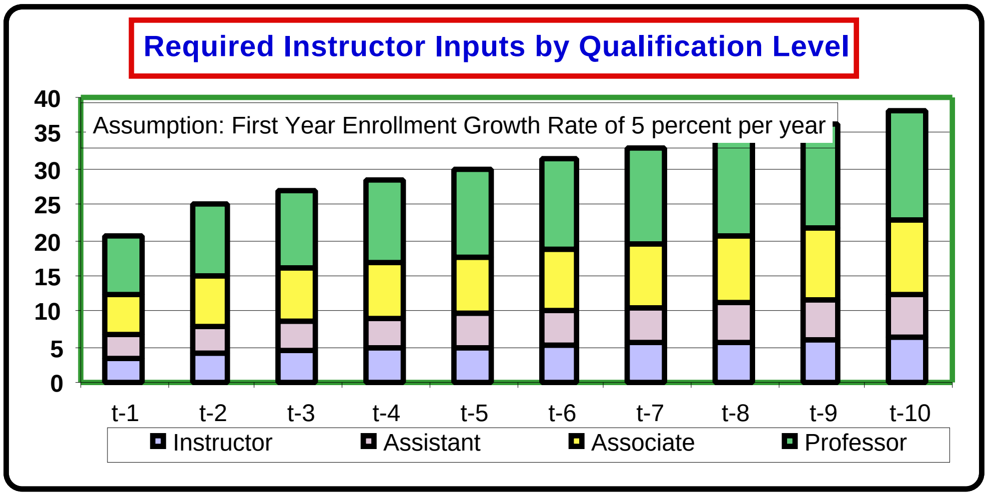
Projected Budget Totals:

Teachers	4.6e5	6.0e5	7.2e5	7.8e5	8.2e5	8.6e5	9.0e5	9.5e5	
Administration		1.7e5	2.3e5	2.7e5	3.0e5	3.1e5	3.3e5	3.4e5	3.6e5
Materiel	7.1e3	9.2e3	1.1e4	1.2e4	1.3e4	1.3e4	1.4e4	1.5e4	
Capital Classes	7.0e4	9.2e4	1.1e5	1.2e5	1.3e5	1.3e5	1.4e5	1.5e5	
Capital Laboratories	3.7e4	4.9e4	5.9e4	6.4e4	6.7e4	7.0e4	7.4e4	7.8e4	
Total: 7.4e5	9.7e5	1.2e6	1.3e6	1.3e6	1.4e6	1.5e6	1.5e6		

Unit Costs:

Teachers	1.1e3	1.1e3	1.1e3	1.1e3	1.1e3	1.1e3	1.1e3	1.1e3	
Administration		408.5	408.5	408.5	408.5	408.5	408.5	408.5	408.5
Materiel	16.65	16.65	16.65	16.65	16.65	16.65	16.65	16.65	
Capital Classes	165.3	165.3	165.3	165.3	165.3	165.3	165.3	165.3	
Capital Laboratories	88.13	88.13	88.13	88.13	88.13	88.13	88.13	88.13	
Total:	$1751	1751	1751	1751	1751	1751	1751	1751	

Figure 3



The Status Quo Option

Maintaining the status quo means essentially preventing educational enrollment ratios from declining, even though, for reasons already discussed, the level of available resources may be relatively fixed or declining. The trade-off here is that in order to accommodate an expanding student population with a fixed budget requires that per student inputs be reduced. Reducing the level of per student input is likely to have adverse consequences on pedagogical efficiency, and thus on the underlying productivity of investment in education.

As an illustration, using the base case student flows model shown in Table 6, suppose policymakers wish to achieve a 50 percent enrollment ratio by year 8 but are constrained from spending more than twice the original base-year budget. As things stand, expanding first-grade enrollments by 5 percent a year will only achieve a 36 percent enrollment ratio by year 8. Even at this level, the projected budget total will be $1.5 million in year 8, more than twice the base-year budget of $745,000. If first-grade enrollments expand by ten percent a year, then the targeted enrollment ratio will be approximately achieved, as is shown in Table 5, but the projected budgetary expenditure will be $2.05 million, or almost three times the base-year budget.

In order to stay within the projected budget ceiling and still achieve the targeted enrollment ratio, policymakers will have to adopt one or more of the following choices: increase the student-teacher ratio, increase the student-classroom ratio, reduce material and administrative inputs per student, or some combination of the above. Each of these steps will have some effect on lowered pedagogical productivity.

Table 7

Disaggregated Educational Forecasting Model

13 Percent First Year Growth Rate

Predicted Educational Outputs and Inputs:

Year:

System: **Budget Constraint Case**

Educational Flow Matrix:				1	2	3	4	5	6	7	8
E-1	E-2	E-3									
1.13			E-1	250	283	319	361	408	461	520	588
.55	.20		E-2	100	158	187	213	241	272	308	348
	.60	.20	E-3	75	75	110	134	155	176	199	224
		.45	Graduates:		34	34	49	60	70	79	89
.30	.20	.35	Dropouts:		121	143	171	198	225	254	287
			Yearly Enrollment:	425	515	616	708	803	909	1027	1160

Educable Cohort Projection:

Base Year Cohort:	2000							
Educable Cohort Growth Rate:	2.5%							
Projected Education Cohort:		2050	2101	2154	2208	2263	2319	2377
Projected Enrollment Ratio:	.21	.25	.29	.33	.36	.40	.44	.49

Table 7 illustrates a hypothetical outcome in which all per student inputs are reduced by 40 percent, input prices remain the same, but in which pedagogical productivity falls. While unit enrollment costs decline from $1751 to $1323, graduate pedagogical productivity declines to 14.6 percent as only 27.3 of every 100 students will now graduate from the system. While the projected budget total for year 8 stays within the $1.5 million constraint, lower pedagogical productivity results in students taking 3.68 years on the average to graduate, and given the same benefits stream illustrated in Table 3, the internal rate of return to education would decline from its original level of 20 percent to 15 percent.

Other things equal, reducing per student educational inputs will lower pedagogical productivity, and thus the private and social return to investment in education. At some point, policymakers will have to assess whether the residual underlying rate of return to education can justify the expenditure of resources. This become more important if lowered educational productivity also results in a lower rate of economic growth for the economy as a whole, reflecting the fact that the return to investment in education has fallen below the rate from alternative forms of investment. It is for this reason that the status quo option is ultimately not an effective solution to the problem.

The Expanding Educational Resource Base Option

Given a choice between the status quo and an expanding base of educational resources, educational policymakers would far and away prefer the latter. Simulating the effects of this option is relatively simple as it involves no constraints on budgetary resources, nor does it create pressures for structural reform within the education sector of the economy. However, because it shifts the educational cost burden elsewhere in the economy, policymakers must justify education's claim to those resources.

In the present economic environment in Africa, unless per capita GNP is rising as population grows, increasing the educational resource base will require a re-allocation of resources from other sectors of the economy. One way of justifying an expansion of resources to education is that the share of Gross National Product in African countries is still somewhat lower than the share among OECD developed countries. However, increasing the share of GNP devoted to education requires that the return to investment in education should exceed the return to alternative investments.

As we have seen through the educational forecasting model, while policymakers may achieve target rates of enrollment ratios, the returns to investment in education may differ significantly. Unless the differential return to education exceeds its opportunity cost, expanding the education share of GNP in African countries could actually lower economic growth. It is for this reason that one needs to examine educational enrollment policies in terms of their economic consequences rather than in terms of whether a particular enrollment ratio has been achieved within a particular time frame, or at a particular cost. This is especially true in many African countries where so much of the cost of education has been borne through public sector spending, and where governments have by and large faced mounting budgetary deficits that have resulted in substantial increases in per capita debt.

Structural Reform in Education

Of the three educational policy options described, structural reform is the most likely choice that policymakers confront. While external economic conditions may improve, the longer-term problem is how to expand the level of education for growing populations in ways that contribute efficiently to the prospects for economic growth and development.

To illustrate how structural reform can shape the range of choices for educational policymakers, let us compare the base case system and the base case constrained case with tuo alternatives, Reform A and Reform B.

In all of these cases, input prices have been kept constant, as have the underlying projected benefits from educational outputs. Under Reform A, per student materiel and laboratory inputs are increased by 25 percent, while all other per student inputs remain the same. Under Reform B, while per student teacher inputs are kept the same as in the base case, per student administrative inputs are reduced by 30 percent, per student materiel inputs are increased by 25 percent, per student laboratory inputs are increased by 10 percent, and per student classroom inputs are reduced by 10 percent. Pedagogical efficiency profiles of these reforms are summarized in Tables 8 and 9, respectively, and horizon year comparisons of these reforms to the base case and constrained base case are shown in Table 10.

Table 8

Disaggregated Educational Forecasting Model
Pedagogical Efficiency Profile

System: **Reform A**

Educational Flow Matrix: E-1	E-2	E-3		Year: 1		Predicted Educational Outputs: 2	3	4	5	6	7	8
.00			E-1	100	=	0	0	0	0	0	0	0
.85	.05		E-2	0	=	85	4	0	0	0	0	0
	.80	.05	E-3	0	=	0	68	7	1	0	0	0
		.65	Graduates		=	0	0	44	4	0	0	0
.15	.15	.30	Dropouts		=	15	13	21	2	0	0	0
Yearly Enrollment:				100		85	72	7	1	0	0	0

A. **Educational Flows Matrix Accounting Identities**:

1. Pupil-Places: 264.80 = Number of Pupil-places provided for through-put of total student cohort.

			(cumulative yearly enrollments)
2. Graduate Pupil-Places:	213.00	=	Number of Pupil-Places provided for all students who eventually graduate from the original cohort (cumulative yearly enrollments minus cumulative dropouts)
3. Graduates:	48.98	=	Number of students from original cohort who eventually graduate
4. Average Graduation Years:	3.11	=	Weighted average number of years to produce one graduate

B. **Pedagogical Efficiency**:

1. Gross:	48.98 Percent	=	Graduates divided by initial student cohort
2. Graduate:	18.52 Percent	=	Ratio of cohort graduates to number of graduate-producing pupil-places. (pupil-places minus cumulative dropouts)
3. Net:	18.49 Percent	=	Graduates divided by the number of total pupil-places.

Now consider another option, Reform A. As can be seen in Tables 8 and 9, under both Reforms A and B, pedagogical productivity increases beyond the base case. However, as is shown in Table 10, in order to achieve a year 8 enrollment ratio of 50 percent requires that the annual budget rise to $2.1 million under Reform A and to $2.0 under Reform B.1. At this point, policymakers can weigh the impact of budgetary constraints under reform programs in comparison to the base case scenario. With no change in per student inputs, Reform B.3 permits one to stay within the $1.5 million year 8 budgetary constraint, but at a cost of lowering year 8's enrollment ratio from .50 to .38. An intermediate course of action would be to accept a somewhat higher total annual budgetary allocation such as under Reform B.2, in which case a somewhat higher enrollment ratio of .41 would be achieved in exchange for a year 8 budgetary expenditure of $1.6 million.

Table 9

Disaggregated Educational Forecasting Model
Pedagogical Efficiency Profile

Predicted Educational Outputs:

System: **Reform B** Year:

Educational Flow Matrix:				1		2	3	4	5	6	7	8
E-1	E-2	E-3										
.00			E-1	100	=	0	0	0	0	0	0	0
.90	.05		E-2	0	=	90	5	0	0	0	0	0

	.90	.05	E-3	0	=	0	81	8	1	0	0	0
		.75	Graduates		=	0	0	61	6	0	0	0
.10	.05	.20	Dropouts		=	10	5	16	2	0	0	0
Yearly Enrollment:				100		90	86	8	1	0	0	0

A. **Educational Flows Matrix Accounting Identities**:

1. Pupil-Places: 284.50 = Number of Pupil-places provided for through-put of total student cohort. (cumulative yearly enrollments)
2. Graduate Pupil-Places: 251.50 = Number of Pupil-Places provided for all students who eventually graduate from the original cohort (cumulative yearly enrollments minus cumulative dropouts)
3. Graduates: 67.31 = Number of students from original cohort who eventually graduate
4. Average Graduation Years:3.11= Weighted average number of years to produce one graduate

B. **Pedagogical Efficiency**:

1. Gross: 67.31 Percent = Graduates divided by initial student cohort
2. Graduate: 26.76 Percent = Ratio of cohort graduates to number of graduate-producing pupil-places. (pupil-places minus cumulative dropouts)
3. Net: 23.66 Percent = Graduates divided by the number of total pupil-places.

Table 10 also illustrates how differing levels of pedagogical productivity alter the proportions of graduate and dropout educated outputs. Year 8 graduates and dropouts range from a low of 294 under Reform B.3 to a high of 454 under the Constrained Base Case. At the same time, the proportion of graduates to total educated output in year 8 also varies substantially. The graduate percentage of year 8's educated output ranges from a low of 20 percent under the Constrained Base Case to a high of 67 percent under Reform B.3. Changes in the mix of graduate and dropout production of educated outputs due to educational reform and/or budgetary constraints can have widely varying consequences on labor market equilibria. Under the constrained base case, reducing the flow of graduate outputs to 89 from its Base Case of 111 would tend to raise the earnings stream of graduates, while the increase in year 8 graduate outputs under Reform B.1 would tend to lower the earnings stream.

Choosing among alternative scenarios depends on policymakers' objectives and constraints. If the goal is to maximize the horizon year rate of return and enrollment ratio with no budgetary constraint, then clearly Reform B.1 is the preferred system. If, on the other hand, policymakers are constrained by a budgetary ceiling, then the choices move progressively away from Reform B.1 toward Reform A or Reform B.2, depending on the relative importance assigned to the returns from investment in education and to the horizon year enrollment ratio. While policymakers may have criteria other than economic efficiency, as long as there is an opportunity cost in the allocation of educational resources, then enrollment ratio goals must be weighed against the underlying productivity of education. As we have seen, one way of doing so is to determine if the underlying productivity of investment in education exceeds its opportunity cost.

Table 10

Alternative Outcomes in Forecast Horizon Year

Forecast Horizon Set at Year 8

System:	Internal Rate of Return	First Grade Expansion Rate	System Total Enrollment	Year 8 Graduates	Year 8 Dropouts	Year 8 Enroll. Ratio	Gross Pedagog. Efficiency	Forecast Annual Total Cost
1. Base Case	20	5	1169	111	198	.49	37.04	1.5e6
2. Base Case Constrained	15	13	1160	89	365	.49	23.20	1.5e6
3. Reform A	25	10	1182	178	202	.50	48.90	2.1e6
4. Reform B Version B.1	31	9	1195	235	123	.50	67.31	2.0e6
5. Reform B Version B.2	31	5	953	204	108	.41	67.31	1.6e6
6. Reform B Version B.3	31	4	900	196	98	.38	67.31	1.5e6

Options for Structural Reform in Africa

For most countries in Africa that are confronting mounting levels of per capita debt service ratios and weak fiscal performance, pressures to limit public sector expenditures on education are substantial. However, as the simulations of the educational forecasting model have shown, implementing structural reforms can result in greater economic efficiency and thus produce a dividend in terms of higher rates of economic growth. How can such reforms be brought about and what do they imply for the future?

Practical reform measures that can improve educational performance include the following: expansion of per student materiel inputs, improving teacher qualifications through in-service training programs, shifting the relative allocation of educational expenditures to the most productive levels of schooling, shifting some of the educational cost burden to the private sector through user fees, student loans, and the promotion of private schooling options. Within the public sector, the argument for shifting the allocation of resources among different levels of education stems from both the relative disparity of per student public expenditures as well as from differences in underlying rates of return to investment in education. Based on data for 30 African countries in 1986, reducing per student educational expenditure inequality can increase per capita income, primarily through a shift in emphasis on elementary and secondary education, for which the results of a simple linear regression are given in equation 4.

(4.) Per Capita GNP $_{(\$U.S.,1986)}$ = 1026.41 - 1324.02(Exp.Inequality)*
(2.063)$_{t(.025)}$

R2 = .1059   226764 = residual variance

X	Y	
.3694	537.2	Mean
.1216	494.8	St. Dev. Sample
.1196	486.55	St. Dev. Population

(*ratio of Higher Education to elementary per student expenditures)

While there are many factors that explain differences in per capita GNP, there is a growing body of research indicating that disparities in per capita student expenditures on education have been inefficient. The inefficiency stems from differential rates of private and social returns among various levels of education, and that the relatively high levels of per student education expenditure at higher levels has not been commensurate with returns. This is not to say that higher education is not an economic investment, but rather than countries may improve the efficiency of public sector expenditures on education by shifting greater relative emphasis to elementary and secondary levels, at least in the near term.

Closely linked to public sector re-allocation of budgetary priorities is the value in imposing some degree user fees beyond the relatively nominal ones now in effect. Education is a quasi-public good. As such, the economic argument regarding the optimal mix of public and private financing of education is straightforward. To the extent that education produces external benefits to society at large rather than to the recipient alone, then it is in society's interest to subsidize the production of education so that such social returns are maximized. Yet as students move through the educational hierarchy, the magnitude of external benefits diminishes in relative importance. For African countries seeking to fulfill the kinds of enrollment goals we have examined, one way to ease the fiscal burden is to impose some level of user fees to higher education consumers, thereby easing the re-allocation of educational resources to elementary and secondary education where the private returns may be smaller.

Using cost recovery at the higher education level inevitably raises the question of whether higher education enrollments would decline significantly. A simple empirical way to answer this question is in terms of the own-price elasticity of demand for higher education. As long as the own-price elasticity of demand for higher education is greater than one, then any increase in user fees will automatically result in a lower level of higher education revenues than the relatively nominal fees now in effect.

Although evidence on the own-price elasticity of demand for higher education user fees in developing countries is limited, Mingat and Tan (1985) suggest that it is sufficiently inelastic at the higher education level that for many countries in Africa at least, elementary education budgets could expand by as much as 40 percent under such a regime. Shifting the higher education cost burden to users is undoubtedly a daunting political task. Yet for African governments that face severe budgetary constraints in the period ahead, the opportunity to achieve near universal primary enrollment ratios is a compelling option. It is compelling not only in terms of enrollment ratio opportunities, but also in terms of the competitive economic value of investment in primary education.

Beyond the efficiency value of re-allocating educational resources is the question of distributive justice. Psacharopoulos (1986) suggests that existing disparities in public educational expenditures may be at odds with prevailing notions of social justice. A higher percentage of students at higher education levels have higher levels of per capita income than students at lower education levels. Disproportionate subsidies for higher education do not reduce the prevailing degree of income and wealth inequality, contrary to declared policies in many countries.

Beyond user fees, scholarships and loans may also work to improve the allocation of educational resources. Williams (1974), Woodhall (1983), and Wolff (1984) suggest that scholarships and loans are a logical complement to user fees. The logic of scholarships and loans in conjunction with user fees is that they respond to some of the inequity that may come about from the shifting of educational costs to users. For African countries, however, educational scholarships and loans represent a relatively new departure in educational finance. As African countries continue to engage in structural reform, it may be necessary to restore fiscal health to existing financial institutions before lending initiatives in education can succeed.

What role can the private sector play in African education? Although education since the 1960's has expanded largely through public sector intervention, private education has played a role. For African countries, one major reason why private education has not found greater support thus far is that it has been so closely associated with Africa's colonial past. During colonial times, education was initially administered mostly by religious missionaries rather than by colonial government administrations. Public education was not considered essential except insofar as it met the needs of training small cadres to assist in colonial administration.

Private educational institutions in Africa today still depend to a great extent on support by religious institutions. In fact, one of the most rapidly growing types of private educational institutions in Sub-Saharan Africa has been the growth of Muslim Koranic and Christian missionary schools. However, it should be emphasized that privatization of education does not require a shift to religious schooling. What is important to note is that there is a private demand for education and that it represents one way of addressing the fiscal pressures that public education institutions confront in the period ahead. As development proceeds in Africa, it is only logical to expect that some form of private schooling will arise, particularly if subsidies to public education systems are reduced. For policymakers, the positive role that private education institutions can play consists of the diversity they can offer, as well as the positive contribution to economic growth that they can make.

Educational achievement in Africa will continue to expand in the period ahead. What Africa's current economic crisis has done has been to force a basic re-evaluation of educational policy. As African policymakers weigh the goals of expanding enrollment ratios in an environment of budgetary restraint, structural reform promises to enhance education's role in successful economic and social development.

Appendix

The tables derived in the text are based on a modified input-output model of education. As noted in the tables, the model is disaggregated into discrete sub-models of educational productivity, educational enrollment forecasting, educational input requirements, and a financial projection model. The following section describes the model in formal terms as well as some of the variations that can be derived.

Pedagogical Efficiency

The educational flows model consists of a transitional probability, or student flows, matrix, A, which can be defined as:

$$(A1.1) \qquad \begin{vmatrix} r_{11} & 0 & 0 \\ p_{21} & r_{22} & 0 \\ 0 & p_{32} & r_{33} \\ & \cdots & \\ & p_{mn} & r_{nn} \end{vmatrix}$$

where: r_{ii} = the repeater rate of the ith grade
p_{ii} = the promotion rate of the ith grade.

In this configuration, there are no limits to the number of times a student may repeat a grade. The repeater rate is based on the mean repeater rate of students enrolled in the grade over time, and is assumed to be invariant with respect to the size of enrollments.

Student enrollments, S, can be defined by grade within a given educational cycle as a column vector:

$$(A1.2) \qquad \begin{vmatrix} E\text{-}1 \\ E\text{-}2 \\ E\text{-}3 \\ \cdots \\ E\text{-}n \end{vmatrix}$$

where: E-1 = enrollment in the first grade of the educational cycle.

From one time period to the next, post-multiplication of A by S yields enrollments in S_{t+1}.

(A.1.3) $S_{t+1} = AxS_t$.

Total enrollments within a given educational cycle is defined as the sum of enrollments in each grade of the cycle. Post-multiplication of a unit row vector times enrollments yields the total number of enrollments at any given time period:

(A.1.4) $p_t = CxS_t$,

where: $C = \begin{vmatrix} 1 & 1 & 1 \end{vmatrix}$, and

$p_t =$ total enrollments at time period t.

Converting the a_{11} cell into a compound growth expression enables one to expand the value of A exponentially to derive the value of enrollments for any time horizon, or to expand the system recursively from year to year.

(A.1.5) $S^n = A_c^n \times S_0$

Projected graduates are based on the addition of a graduate row vector, which for a three-year education cycle can be defined as:

(A.1.6) $G = \begin{vmatrix} 0 & 0 & 0_{43} \end{vmatrix}$

where g_{ii} = graduate rate from the terminal year of the cycle.

Post-multiplication of the graduate row vector by the column vector of enrollments yields the number of graduates in the following time period:

(A.1.7) $g_{t+1} = G_t x S_t$.

Projected dropouts can be calculated as the sum of dropouts from all grades within the cycle at any one time, or one can also define dropouts by dropout grade. As used in the text, dropouts are defined as an aggregate of dropouts from all three grades. So calculated, dropouts are estimated form a row vector of dropout rates for all grades, which for a three-grade education cycle is defined as:

$$\text{(A.1.8)} \quad D' = \left| d_{51} \quad d_{52} \quad d_{53} \right|$$

Post-multiplication of the dropout row vector by the column vector of enrollments at time t yields the number of dropouts in period t+1.

$$\text{(A.1.9)} \quad d_{t+1} = D'_t x S_t.$$

Consistency requires that in the absence of compound growth for r11, the allocation coefficients of each column sum to unity.

Pedagogical efficiency can be measured in several ways. Gross pedagogical efficiency is defined as the ratio of graduates to total enrollments form the flow of a given cohort through the educational cycle.

$$\text{(A.1.10)} \quad PEDEFF^{p} = (\sum_{t=1}^{n}) g_t / E\text{-}1_1.$$

Uncompensated graduate pedagogical efficiency is defined as the ratio of graduates to the number of graduate producing pupil-places of total enrollments from the flow of a given cohort through the educational cycle:

$$\text{(A.1.11)} \quad PEDEFF_{u}^{n} = (\sum_{t=1}^{n})[g_t/(p_t - d_t)].$$

Uncompensated net pedagogical productivity is the ratio of graduates to the total number of pupil-places generated by the flow of a given cohort through the educational cycle. It is expressed as:

$$\text{(A.1.12)} \quad PEDEFF^{n} = (\sum^{n})[g_t/p_t].$$

u   t=1

Compensated graduate pedagogical efficiency is derived as the product of uncompensated graduate pedagogical efficiency times the theoretical number of years to complete the educational cycle:

$$\text{(A.1.13)}\quad PEDEFF^{g}_{c} = PEDEFF^{g}_{u} \times Y,$$

where: Y = the theoretical number of years to complete an educational cycle.
Y = 3 in the present example.

The average number of years required to produce a graduate is defined as:

$$\text{(A.1.15)}\quad \bar{Y} = [(\sum_{t=1}^{n})g_t x p_{t-1}/(\sum_{t-1}^{n})g_t],$$

where $\bar{Y}$ = the mean number of years, based on the flow of an initial cohort through the education cycle.

Derivation of unit graduate annual enrollment costs is based on several adjustments to the annual unit enrollment cost. First, one calculates the total graduate cost adjustment factor, which is defined as the ratio of graduate pupil-places to the number of graduates from a cohort:

$$\text{(A.1.16)}\quad TGCAF = (\sum_{t=1}^{n})[p_t - d_t]/(\sum_{t=1}^{n})g_t,$$

where TGCAF = total graduate cost adjustment factor.

Next, the annualized graduate unit cost adjustment factor is defined as the ratio of the total graduate cost adjustment factor to the average number of years needed to produce a graduate:

$$\text{(A.1.17)}\quad AGUCAF = TGCAF/\bar{Y}.$$

The product of the annualized graduate unit cost adjustment factor times the ith unit year that a graduating student is enrolled yields the annualized unit graduate enrollment cost of the system:

(A.1.18) $AUGEC_t = AGUCAF \times U_t$,

where $AUGEC_t$ = annualized unit graduate enrollment cost in year t,

U_t = unit enrollment year, or fraction thereof, in year t. $U \leq 1$ for all t.

A.2 Educational Input Requirements and Budget Projections

Projecting an estimated annual budget needed to sustain a given level of enrollments is based on the specification of educational input requirements. The reference case is based on the assumption that input requirements per student are invariant to the number of enrollments, just as in the formulation of the student flows matrix. Teacher input requirements can be defined as a column vector, T, which specifies the per student teacher inputs by level of teacher qualification in educational cycle i. For a system utilizing teachers with three different levels of qualification, T is thus:

$$(A.2.1) \quad T^i = \begin{vmatrix} v_{1i} \\ v_{2i} \\ v_{3i} \end{vmatrix}$$

Multiplying T by the number of students enrolled in cycle i at time t yields a column vector of required teachers:

$$(A.2.2) \quad \hat{T}_t = T_t \times p^i_t.$$

In turn, the total number of teachers is the sum of required teachers by level of qualification needed to sustain the projected enrolllment level. In matrix notation, it can be derived as the product of a unit row vector times the total number of projected students enrollment at time t:

$$(A.2.3) \quad T_t = C \times \hat{T}_t.$$

The student-teacher ratio is thus:

(A.2.4) p_t/T_t .

Administrative and materiel inputs are based on similar calculations as in the case of projected teacher inputs. Administrative input requirements per student are represented as a column vector, which for a three-level administrative hierarchy can be defined as:

$$(A.2.5)\quad I^{i} = \begin{vmatrix} s_{1i} \\ s_{2i} \\ s_{3i} \end{vmatrix}$$

where s_{ii} = the per student ith level administrative input in education cycle i.

Post-multiplying the per student administrative input requirements by the number of students at time t yields the total number of required administrative inputs by level of qualification:

$$(A.2.6)\quad \hat{I}_t = I_i \times p_t .$$

Similarly, one can define a column vector of per student material inputs which can then be post-multiplied by the level of student enrollment to derive the required level of material inputs needed to sustain a given enrollment level. A three-category grouping of per student material inputs is defined as:

$$(A.2.7)\quad M_i = \begin{vmatrix} m1i \\ m2i \\ m3i \end{vmatrix}$$

At time t, given student enrollments of pt, total required material inputs are thus:

$$(A.2.8)\quad \hat{M}_t = M_i \times p_t .$$

Classroom and laboratory inputs per student are used to derive the total number of required classrooms and laboratories to sustain a given level of enrollment. For classrooms, total units required at time t is defined as:

(A.2.9) $C_t = C \times p_t$,

where C = a per student classroom unit scalar.

For laboratories, total units required at time t is defined as:

(A.2.10) $L_t = L \times p_t$,

where: L = a per student laboratory unit scalar.

Given input unit prices, the corresponding levels of total budgetary expenditure needed to sustain a given enrollment level can be specified by input. For teacher costs at time t, projected expenditures are given as:

(A.2.11) $\hat{TE} = T' \times p_i^t \times p_t$,

where: T' = a row vector transpose of per student teacher input coefficients,
P_t = a column vector of per teacher input prices,
p_t = total student enrollments at time t.

Administrative and materiel expenditure projections are defined similarly as:

(A.2.12) $\hat{IE} = I'_i \times P_i^a \times p_t$,

(A.2.13) $\hat{ME} = M'_i \times P_i^m \times p_t$.

Classroom expenditures take into account the levelized payment and maturity of classroom costs. Total classroom expenditures at time t are thus defined as:

(A.2.14) $\hat{CE} = C \times p_t \times PMT^c$,

where: C = per student classroom input scalar coefficient,
p_t = total student enrollment at time t,

PMT^c = levelized per classroom annual cost,

$$= \frac{PV(r)(1+r)n}{[(1+r)n - 1]}$$, where:

PV = the per classroom present value cost,
r = the applicable rate of discount,
n = the amortization period per classroom.

Laboratory expenditures are defined similarly as:

$$\text{(A.2.15)}\quad LE = \hat{L} \times pt \times PMT^{l} ,$$

where: L = per student laboratory input scalar coefficient.

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