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EXERCISE IN THE ARITHMETICK OF EDUCATIONAL PLANNING

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This paper lays little claim to originality of approach. The methods of calculation used do however have the merit of simplicity and are easy to handle. Our principal concern is the cost implications of alternative target rates of enrolment at various levels of education. For reasons which will become evident as the argument develops our principal interest lies in the unit cost of education (i.e. the average cost of one student-year of education at a given level), expressed not in terms of monetary units but as a fraction (or multiple) of monetary G.D.P. per capita.

If the recurrent "unit cost" of education at a given level is "a" times GDP/capita, and if the relevant age group is "b" of GDP, & if the enrolment target is set at, say, "c" of the age-group, the annual cost of that target would be "abc" of G.D.P. (if average cost = marginal cost (1)).

While it is evident that this calculation holds for the immediate achievement of a given enrolment-target, it will be clear on further inspection that this enrolment target will cost "abc" of any future national income also, no matter how distant, if "a" (the unit cost of education) and "b" (the relevant age-group as a percentage of total population) do not change.

With population growing at a constant rate, its age-structure changes very slowly. For periods of up to 25 years it is legitimate to assume, therefore, that "b" may be presumed to be constant. We shall, therefore, concentrate our attention on "a" (unit-costs) and "c" (alternative enrolment ratios).

An actual example based on estimated recent Uganda figures will illustrate the uses of what so far may have appeared as an arid exercise in simple arithmetic.

TABLE I. Recurrent cost of various levels of education - Uganda

School Level	Av recurrent cost per student p.a. £	Cost in G.D.P. units (= 820)	Duration (yrs)	Cost of full course in G.D.P units
Primary *	10	0.5	7**	3.5
Senior Secondary (S.1-6)	150	7.5	6	45.0
University	1000	50.0	3	150.0

* includes Jr.Sec.
** still 8 years in 1964, becoming 7 years from 1965 onwards. For planning purposes we can asume the new system to be in operation

Source: Annual Reports of Ministry of Education.
Report of the Sozi Committee on Secondary School Costs, 1964.

For an "operational" as opposed to an illustrative model, we would include all types of post-primary education, not all of which have the same duration.

(1) The ability to seek out and achieve marginal costs which are below average costs is, of course, the greatest accomplishment of the practical planner.

or per capita costs as the "typical" 2nd and 3rd level courses (i.e. senior secondary education up to H S C and university education for a 3- year degree) included in Table I

Thus a full secondary course uses as much resource as the average Ugandan produces in a lifetime, while the cost of a 3-year degree is three average lifetimes' output!

We may now proceed to the next stage of analysis

TABLE 2

Recurrent Cost Implications of Enrolment Ratios at Various Levels of Education

School Level	(1) Normal age range	(2) Age group as % of population	(3) Annual unit cost in G.D.P inits	(4)=(2)x(3) Cost of universal provision as % of G.D.P %	(5) 1964 Actual enrolment as % of age range %	(6)=(4)x(5) ost of actual enrolment as % of G.D.P
Primary	7-13	16.3	0.5	8.15	41***	3.34
Secondary I*	14-17	7.4	7.5	55.50	3	1.67
Secondary II**	18-19	3.5	7.5	26.25	0.27	0.07
University	20-22	5.2	50.0	260.00	0.13****	0.34
				350.00		5.42

* Includes S.1-4, TTCs and Technical Schools.
Unit costs assumed to be the same as for senior secondary schools. These costs depend on the present balance between boarding and day-schools, the latter being significantly cheaper.

** S.5-6 only. Exact costs hard to establish: the assumption that they are the same as S.1-4 probably understate s them.

*** Actual duration in 1964 still 8 years, hence true enrolment rates about 39%.

**** Includes only university students in East Africa. Cost of overseas students borne almost entirely by foreign governments It is unwise to assume that we can escape these costs by having abroad a much larger number than there are at present.

Though the cost figures are only fairly rough approximations certain valid general conclusions nevertheless emerge.

Uganda is already (1964) spending almost 5½% of her monetary G.D.P on the recurrent costs of education alone. (Capital costs in recent years have been financed largely by overseas gifts and donations It would be unwise to assume that this will continue indefinitely.) This is one of the highest rates in the world While all such judgements are arbitary I would suggest that this proportion cannot rise above 6% of monetary G.D.P (It was already over 20% of Central Governemnt revenue in 1964.)

Education is a fabulously expensive industry. The figures in col. (4) of the preceding table may have failed to produce their due impact because 100% enrolment at all levels of education has never been seriously contemplated anywhere, except perhaps in the U.S.A. We may therefore "cost" an enrolment pattern which bears distinct resemblance to targets now under serious discussion. This would involve (i) seven years of universal primary education; (ii) 4 years of secondary education for 10% of the age-group; (iii) 2 years of "sixth form" work for 2% of the age group; and (iv) 3 years of university education for 1% of the age group The costs of these targets are shown in Table 3 below:-

TABLE 3. Recurrent Costs of Possible Target Enrolment Ratios

School Level	(1) Target Enrolment Ratio %	(2) Annual Recurrent Cost as % of G.D.P	(3) Percentage Distribution of costs
Primary	100	8.15	48
Secondary 1-4	10	5.55	33
Secondary 5-6	2	0.53	3
University	1	2.60	16
		16.83	100

Col. (2) is derived by multiplying Col. (4) of Table 2 by the target enrolment ratios.

An educational budget involving 17% of G D P. is not a practical proposition. If this programme is to be within the range of possibility, (2) the average cost of education in relation to G.D.P. per capita must be reduced by two thirds. So long as the unit-costs of education (in G.D.P./ units) remain the same, the above programme will continue to represent 17% of G D.P. this year, next year, or a generation hence This would tend to happen if the earnings of those engaged in the "education industry" continued to rise at the same rate as G.D.P per capita.

For the moment, however, let us make the optimistic - though somewhat improbable - assumption that the absolute unit costs of education (3) at each level can be held constant at their estimated 1964 levels We shall further assume that population is growing at the officially estimated rate of 2.6% p.a. and that the age structure of population remains unchanged.

We shall then ask two related questions:

(i) at a 5% average rate of growth of G D.P how long would it take for the targets given in Table 3 above to become feasible (feasibility being defined as total annual recurrent cost not exceeding 6% of monetary G.D.P)?

(ii) assuming that we wished to reach our target in 15 years i.e. by 1980, what would the rate of growth of G.D.P. have to be to make this feasible?

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(2) defined as 6% of G.D.P.

(3) i.e. costs measured in £-s-d

(i) Let the absolute costs of the desired pattern of education in the last period and in the final year be C_o and C_1 respectively.

$$C_o = \frac{16.83}{100} \quad Y_o \qquad \text{.....(1)}$$

$$C_1 = \frac{6}{100} \quad Y_1 \qquad \text{.....(2)}$$

The absolute level of educational costs rises only because of population-growth, hence

$$C_1 = (1.026)^n \, C_o \qquad \text{.....(3)}$$

Income has been rising at a rate of 5% p.a., hence

$$Y_1 = (1.05)^n \quad Y_o \qquad \text{.....(4)}$$

Therefore (from (1) and (3)):-

$$C_1 = 1.026^n \left(\frac{16.83}{100}\right) \quad Y_o \qquad \text{.....(5)}$$

and (from (2) and (4)):-

$$C_1 = \frac{6}{100} (1.05)^n Y_o \qquad \text{.....(6)}$$

Hence

$$(1.026)^n . \quad 16.83 \quad \frac{Y_o}{100} = (1.05)^n \, 6 \, \frac{Y_o}{100}$$

$$\left(\frac{1.05}{1.026}\right)^n = \frac{16.83}{6} = 2.8$$

i.e. the educational target will fall within the budget constraint when per capita income will have risen 2.8 fold.

$$\frac{1.05}{1.026} = 1.023$$

$$1.023^n = 2.8$$

$$n = 45.6.$$

Thus, even on the (wildly optimistic) assumption that the absolute unit costs of education can be held constant indefinitely while per capita incomes are rising, the achievement of this educational target would take 46 years (given our assumptions about the 6% budget constraint and about the rates of growth of population and GDP.) (Another way of stating our conclusion is that the unit-cost of education measured in GDP units must fall by two thirds of our enrolment target is to become feasible.)

(ii) The arithmetic of the second problem is basically similar.

$$C_{15} = C_o \cdot \quad 1.026^{15} \qquad \ldots\ldots\ldots(1)$$

$$C_o = \frac{16.83}{100} \; Y_o \qquad \ldots\ldots\ldots(2)$$

$$C_{15} = \frac{6}{100} \; Y_{15} \qquad \ldots\ldots\ldots(3)$$

$$Y_{15} = x^{15} \; Y_o \quad \text{(where x is growth rate of Y)} \qquad \ldots\ldots\ldots(4)$$

Combining (1) and (2) on the left-hand side and (3) and (4) on the right-hand side, we get :-

$$16.83 \; Y_o \cdot \quad 1.026^{15} = 6 \; Y_o \; x^{15}$$

$$\frac{16.83}{6} \cdot 1.026^{15} = x^{15}$$

$$x^{15} = 2.8 \cdot 1.468 = 4.110,4$$

$$x = 1.098$$

i.e. our education target is attainable within 15 years (and within the 6% budget constraint) if GDP is growing at a (compound) rate of 9.8% per annum, while the money unit-costs of education remain constant throughout this period. (Thus, doubling the growth-rate reduces the "waiting period" by two thirds).

There is, of course, nothing sacrosanct about any particular pattern of enrolment ratios such as those we set up as our target (except to the extent we believed them to be ends in themselves). The crucial problem of manpower-planning is raising the stock of educated people, both absolutely and relative to total population. The raising of enrolment-ratios is but a means to this end.

What we have illustrated, however, is a method of (partially) testing the feasibility of achieving a desired increase in per capita output by a stated target date. If the "manpower-requirements" of (say) doubling per capita incomes over 15 years required for their achievement a pattern of enrolment ratios which could only be reached if per capita incomes trebled over this period, the plan is internally inconsistent. This approach may later be applied to an examination of East African development plans and related plans of manpower and educational development. The immediate point of interest, however, is that the hypothetical examples of planned enrolment ratios given in Table 3 do, broadly, correspond to the quantitative thinking of East African Education Ministries about the next 15 years or so. With recent growth rates of GDP (of the order of 3-5% per annum), these plans may not be realisable for another 40-50 years; and even with the ambitions 7-8% growth targets under discussion, they approach feasibility only after 20 years of rapid growth - and only on the assumption of constant unit-costs of education.

We must now turn to examine the reasonableness of this assumption.

The feasibility of meeting our educational targets depended, as we saw, on our ability to reduce, on the average, the unit-costs of education by about two-thirds, in relation to GDP per capita. The preceding calculations proceeded on the assumption that this might be achieved by raising GDP/capita while holding the monetary costs of education at their present level. An alternative which is more likely (but would postpone the achievement of our targets to an even further date) is that both the unit-cost of education and GDP/capita are rising, but that the latter rises faster than the former. We have already seen that if educational unit costs rise as fast as (or faster than) GDP/capita, our targets will forever remain out of reach.

The principal element in the costs of education is the salaries and other emoluments of teachers. A recent report[4] based on a 50% sample of senior secondary schools found the following cost pattern in senior secondary schools in Uganda for 1962:-

Table 4. Unit Costs of Secondary Education in Uganda

Annual unit. Cost per student		Salaries	Tuition Materials	Boarding materials	Administration	Amortisation	TOTAL
C.S.C.-Boarding	(£)	57	15	34	8	56	170
	(%)	33.5	8.8	20.0	4.7	33.0	100.0
C.S.C.-Day	(£)	57	7	-	4	8	76
	(%)	75.0	9.2	-	5.3	10.5	100.0
H.S.C.-Boarding	(£)	100	16	34	12	65	227
	(%)	44.1	7.0	15.0	5.3	28.6	100.0
H.S.C.-Day	(£)	100	16	-	3	15	134
	(%)	74.6	11.9	-	2.2	11.3	100.0

4. Report of the Sozi Committee on Secondary School Costs, March, 1964, Ministry of Education, Uganda.

The detailed cost implications of any programme of educational expansion will of course, depend in part on the balance between boarding and day schools at the post-primary level and on our success in reducing the very high capital costs per student. (A good start in this direction has already been made in Uganda with the recent introduction of more modest building standards by the Ministry of Education.) This should not, however, obscure the fact that the dominant component of educational costs is the salaries and other emoluments of teachers. They are, in fact, significantly higher than those which appeared in Table 4, as those figures exclude not only the expatriation element (mainly borne now by the U K.), and contract gratuities, but other benefits such as passages, educational allowances, free health services, subsidised housing, etc., which together may increase the average teacher salary by as much as 50%. It seems legitimate, therefore, to concentrate our discussion at this stage on the question of teachers' salaries.

Before entering into a general discussion it is neccesary to stress the point that, while teacher salaries may be too high in relation to GDP per head they are clearly too low in relation to salaries available to East African graduates outside the teaching profession Starting salaries in teaching are 15-25% below the corresponding salary the average East African gratuate can expect to get elsewhere, while promotion prospects are even more inferior relative to other "graduate" occupations (5)

The relative financial standing of the teaching profession is undoubtedly a major (if not the major) factor determining its ability to recruit, and the necessity to improve the relative earning prospects of teachers should not be lost sight of in the discussion which follows

The problem is nothing if not tricky. The preceding discussion suggests that unless we succeed in reducing teacher salaries absolutely (and reducing other graduate salaries even more), our target may take two generations to reach at moderate (and probable) rates of growth, or something like a generation if we assume a growth rate approaching 10% p.a. An absolute reduction of graduate salaries is politically hardly feasible (though it is socially desirable). The experience of recent years suggests that -- in the absence of a national wage policy -- the reverse is more likely, i.e., that teacher salaries will rise as fast as GDP, if not faster

Indeed, the demand for graduates being fairly directly linked to the level of GDP a fall in graduate salaries relative to GDP is unlikely, unless we succeed in increasing the stock of graduates faster than the rate of growth of GDP Previous calculation on this score(6) suggest that this is unlikely to happen for the next 15 years or so. for reasons which are part physical/(shortage of funds) Evidently, the argument is beginning to resemble a dog running around in circles trying to catch its own tail. The scarcity of

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(5) Salaries of expatriate teachers are competitive being about 15% higher than the salaries of university lecturers with the same length of experience.

(6) Rado & Jolly, "The Demand for Manpower - An East African Case S tudy", EDRP 44.

/ (shortage of students) and part financial

graduates (hence their high price) retards the acceleration of their production, which would lower their price and make expansion more feasible. A high rate of growth, though increasing our ability to pay for graduates, also increases the demand for them, leaving their relative scarcity (probably) unchanged.

No intellectual sleight of hand, no financial wizardry can conjure away genuine scarcity. Yet few would deny that the present level of earnings of East African graduates -- teachers and others -- includes a very substantial element of quasi-rent. Their salary levels may be a rational means of allocating them among individual enterprises, but they are not necessarily rational from national point of view, in the sense of being greatly in excess of what is required to call forth their effort both in the short run and in the long run. Thus, while an absolute reduction in the salaries of "high-level" personnel (though desirable) is not feasible,(7) a firm (though possible undeclared) salary-freeze at present levels does appear to be a reasonable possibility to aim for.

Would it achieve anything? To the extent that the scarcity of teachers and other "high-level" personnel is a real constraint on growth, a reduction in their relative salaries would not make them any less scarce. Our case must rest on the argument that such a step would free other scarce resources which could be used in the development process. Would it?

It appears to me that it would. To the extent that it increased the disposable resources of government it would permit a corresponding increase in investment -- including, or even specifically, investment in education. While it would/increase the number of overseas teachers the government could recruit, and pay for and thus the number of pupils who could be enrolled and trained. Its full effect would clearly depend on the extent to which the resources freed would be substitutable for the government's purposes, but there is no reason to believe that such possibilities of substitution are inconsiderable.

The preceding argument has been clearly sketchy and insufficiently documented with empirical content. I would, nevertheless, contend that it has shown:

(i) that if present salary levels for the highly educated (in"GDP units") continue, any substantial rate of educational expansion will be possible only to the extent it is financed by overseas aid;

(ii) that even if present absolute salary levels continue, unprecedentedly high rates of economic growth will be necessary to pay for the implied costs of education;

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(7) It might, however, be feasible to increase substantially the taxation of higher incomes. To avoid the disincentive effect on overseas recruitment it would be necessary to make expatriation allowances and contract gratuities tax exempt -- a technically feasible measure which would not greatly increase the government's popularity

/ not increase the number of East African teachers immediately, it would

(iii) that if "high-level" salaries cannot be absolutely reduced (by taxation or otherwise) a salary-freeze does offer a way (albeit not a rapid way) out of our dilemma.

Though the work on it is still incomplete, Uganda now has the outlines of a sound and defensible manpower plan. The line of approach embodied in this paper may be suitable for testing the feasibility of its educational implications (which are yet to be worked out), and for developing an overall incomes policy without which I believe, any ambitious plan is bound to founder and sink.