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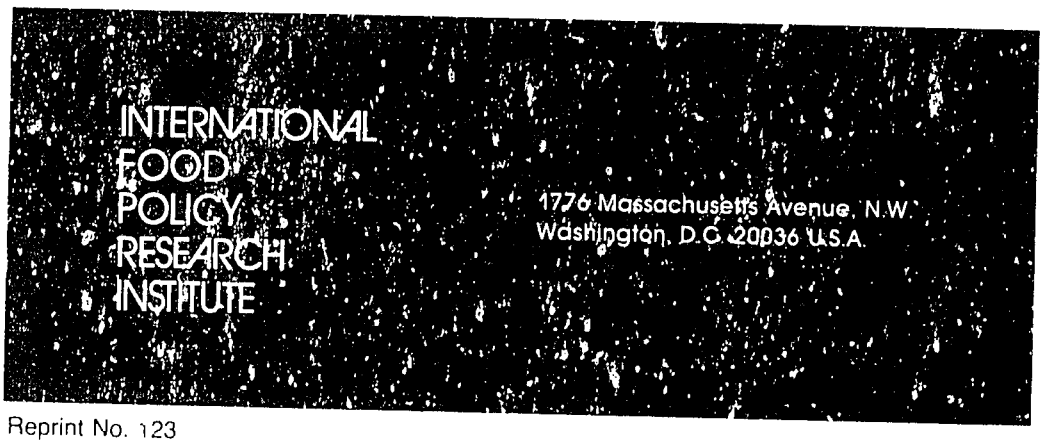

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EDUCATIONAL POLICY AND LABOUR PRODUCTIVITY: AN OUTPUT ACCOUNTING EXERCISE*

J. B. Knight and R. H. Sabot

What is the contribution of education to output, productivity or their growth? Economists have tried to answer this question using output accounting or growth accounting – by the decomposing of output or its growth into the contributions of various factors, including education.

The approach in this paper is output accounting, of which Krueger (1968) provides an early example. Using crude aggregate census data on some 20 – mostly developing – countries, Krueger posed the question: how much do differences in educational endowments lead to differences in per capita income? She estimated the effect on per capita income in the United States of assuming not the U.S. educational distribution but the distribution in each other country. The size of this effect was then related to the differences in per capita income. Krueger explained more than half the difference in per capita income by differences in human capital, and so concluded that human capital (defined more broadly than educational attainment) contributed more than all other factors combined. Another version of the same exercise, but using a three-factor production function, was conducted by Fallon and Layard (1975), with similar data sources but for a different set of countries. They found the contribution of their index of human capital to be lower than Krueger's estimate and generally lower than that of physical capital.

Output and growth accounting both suffer from well-known drawbacks (see, for instance, Bowman, 1980 and Nelson, 1981). First, failing to take account of the other determinants of income can bias estimates of the difference in income and productivity attributable to education. Secondly, in simply assuming that the (standardised) earnings difference between the educated and uneducated measures the productivity of education, output and growth accountants attribute causation to what may at least in part be a non-causal correlation. The relation between education and earnings may reflect payment for unmeasured 'natural ability' or for educational qualifications irrespective of their economic value, i.e. 'credentialism'. This effective equating of the marginal products of factors to their remuneration has led some practitioners to treat growth accounting as no more than 'a first step' that 'cannot be relied upon to give answers to counterfactual questions' (Matthews *et al.* 1982, p. 15). Adjustments to the earnings difference to estimate the marginal product of education have in general simply attributed an arbitrary proportion of the

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difference in earnings to ability or other correlates of education (see, for instance, Denison, 1967, pp. 82–7).

Thirdly, these accounting exercises are generally conducted over time periods or across economies that differ much in the relative supply of and the relative demand for educated labour. Differences in the structure of factor prices or their marginal products according to factor endowments and the characteristics of production functions make the answers to the counterfactual questions being posed unreliable.[1] Krueger (1968, pp. 643–5) argued that her estimated contribution of education would give a minimum estimate, essentially because the marginal product of human capital in the United States would be relatively low if the United States was well endowed with human capital. But her estimate would not be low if the U.S. economy had a greater relative demand for human capital.

In this paper we minimise these three drawbacks by examining a 'natural experiment' in Kenya and Tanzania. These countries differ in their educational policies, but they are sufficiently similar in relevant respects other than the supply of educated labour. In particular there is evidence that the relative demand functions for different categories of educated labour are very similar in the two economies (Knight and Sabot, 1983, 1984). The analysis here is based on two, strictly comparable, sets of microeconomic data. Earnings functions can therefore be used in place of mean earnings by educational level. The data sets provide information on the educational attainment of workers and on their cognitive skills and reasoning abilities. The measures of cognitive skill and reasoning ability enable us to isolate human capital from the screening and credentialist effects of education, thereby improving on conventional estimates of the marginal product of education. The measures make possible an estimate of the effects on output of the difference between the two countries not only in the quantity but also, by means of educational production functions, in the quality of education.

Section I contains a brief account of the data and the setting for the analysis. Section II presents estimates of a recursive model of cognitive skill acquisition and earnings determination. Section III examines how much the divergent educational policies in the two countries have generated measurable differences in the quality of education provided. In Section IV a method is developed for estimating the effect of education on the cognitive skills of workers and on their earnings and productivity. In Section V we conduct policy simulation exercises which show the effect in one country of adopting the other's policies relating to the quantity and quality of education. This permits an estimate of the contribution of educational policies to the productivity of workers. Section VI sums things up.

[1] Attempts in growth accounting to allow for non-marginal educational expansion have used assumed or estimated elasticities of substitution between education and other factors to measure the effect on factor prices and factor weights (see, for instance, Dougherty, 1971 and Selowsky, 1971); attempts to allow for the changing structure of factor prices have involved the use of a chain-linked Divisia index (see, for instance, Jorgenson and Griliches, 1967).

I. THE SETTING AND THE DATA

The natural experiment has been in progress in East Africa over the last twenty years. Kenya and Tanzania are similar in size, colonial heritage, resource endowment, structure of production and employment, and level of development. Nor do technical conditions or physical capital intensity differ much for their urban wage economies. The countries differ markedly, however, in one key dimension of the supply of educated labour, the dimension we are interested in: the emphasis on secondary education. Kenya and Tanzania achieved political independence in the early 1960s with administratively similar but very undeveloped educational systems and negligible stocks of indigenous educated manpower. In 1962 primary enrolment (standards I–VIII) as a proportion of the relevant age group was 47% in Kenya and 23% in Tanzania, and secondary enrolment (forms I–IV) was 3% in (25,000) Kenya and 2% (14,000) in Tanzania. Both countries have now come close to the objective of universal primary education, with a primary enrolment ratio in 1980 of more than 100% in Kenya and of 88% in Tanzania. And university enrolments remain at less than 1% of the relevant age group. It is with secondary education that the main policy issue arises in East Africa.

Enrolments in secondary education have diverged: in Kenya, with a slightly smaller population, the secondary-school enrolment ratio was 25% (400,000 pupils) in 1980, and in Tanzania it was 4% (60,000 pupils). Secondary education is tightly rationed in Tanzania for reasons of financial and manpower planning, whereas both the public and private sectors have been more responsive to demand in Kenya. The Tanzania government started with a smaller system, accepted that post-primary education should not be expanded beyond the requirements of the economy as gauged by existing input–output relationships, and gave budgetary priority to primary education and literacy. These differences in supply are reflected in the educational composition of the wage-labour forces in the two countries. Differences may also have grown in the quality of secondary education. The private and self-help system burgeoned in Kenya, and Tanzania adopted an egalitarian approach to secondary schools and stressed Kiswahili rather than English as the medium of instruction in primary schools.

To subject this experiment to quantitative analysis we required rigorously comparable data. Two surveys were therefore administered within a few months of each other in 1980 by a team including the authors. The samples, each containing nearly 2,000 employees, were randomly selected on an establishment basis, using a two-stage procedure, from among the wage-labour forces of Nairobi and of Dar es Salaam.[1] The surveys were confined to the

[1] The sampling frame was the full list of establishments in the capital city, provided by the government statistical service in each country. All employing establishments with fixed addresses were covered in principle, but very small firms were likely to be under-represented in the frame. The sample was stratified on the basis of sector (manufacturing, government, other non-manufacturing). The non-government establishments were also stratified according to size measured by the number of employees. Roughly 70 establishments were selected in each country. Within each establishment, employees were sampled on a random basis, the sampling fraction ensuring stratification of employees by establishment size. Non-response by firms and employees was negligible.

capital cities because of the high concentration of employed secondary-school leavers in urban areas and because previous labour market survey work had suggested that a capital was not unrepresentative of urban areas in respect of relevant wage-employment characteristics.[1] The surveys provide information on the earnings, education, employment experience and other characteristics of respondents.

We also have information on the worker's cognitive skill and reasoning ability – two measures not previously found in studies of developing countries and only rarely found in studies of the education–wage relationship in developed countries. Our measure of cognitive skill is the combined score in the tests of literacy and numeracy designed by the Educational Testing Service of Princeton specifically for use in these surveys. The designs were based on questions in language comprehension and mathematics from the national primary school-leaving and secondary school-leaving examinations and on other guides to the content of the academic curriculum, which is much the same in the two countries. The major difference is that the use of Kiswahili is stressed more in Tanzania; questions were therefore set in both English and Kiswahili for respondents to choose the language they preferred. Reasoning ability was tested with 'Raven's Progressive Matrices' (Raven, 1956). Widely used in developing countries, this test involved matching pictorial patterns, for which literacy and numeracy provide no advantage (see, for example, Klingelhofer, 1967, Sinha, 1968 and Wober, 1969). All three tests appear to have been appropriate for the target groups: the frequency distributions of test scores reveal considerable variance on each test but very few perfect scores and no zero score.

Not all respondents were given the tests which yielded our measures of reasoning ability, literacy and numeracy: testing was confined to a subsample of primary school and secondary school completers. The primary school completers left school after standard VII (standard VIII before the withdrawal of the eighth standard in each country) and the secondary school completers after form IV. From the primary- and secondary-completers in the two samples (just over 900 in each country), two subsamples of about 200 were randomly selected for testing.[2] The size of the subsamples was determined by time and cost constraints,[3] and the educational stratification was chosen because of policy interest in the economic value of the four-year course of secondary education. In each educational stratum the subsamples were found to be well representative of the larger samples. The analysis of this paper is necessarily based entirely on the tested subsamples.

[1] See Sabot (1979), which compared Dar es Salaam with other towns in Tanzania. In relation to the urban areas in general the capital cities may have an over-representation of government services (20 and 25% of employees in Nairobi and Dar es Salaam respectively) and manufacturing (20 and 23%) and an under-representation of small firms (9% in establishments with fewer than 20 employees in both cities).

[2] The subsample was stratified into primary- and secondary-completers (roughly 100 of each) in order to ensure that there would be adequate numbers in each educational stratum. The regression analysis based on the subsample uses the unweighted data, but for mean values of the dependent and independent variables (required in the simulation analysis) the subsample is weighted according to the ratio of primary- to secondary-completers in the full sample. Non-response to the tests was negligible.

[3] It took half an hour per respondent to complete the questionnaire and an hour per respondent to administer the tests.

II. A MODEL OF COGNITIVE SKILL ACQUISITION AND EARNINGS DETERMINATION

We posit a recursive model represented in the following two equations:

$$H = a_0 + a_1 R + a_2 S + a_3 T + a_4 B + a_5 G + U \tag{1}$$

$$\ln W = b_0 + b_1 R + b_2 S + b_3 H + b_4 L + b_5 L^2 + V \tag{2}$$

where

H = cognitive skill score
R = reasoning ability score
S = a dummy variable indicating completion of secondary schooling, the omitted subcategory being completion of primary schooling
T = years since leaving school
B = a dummy variable indicating birth in an urban area, birth in a rural area being the omitted subcategory
G = a dummy variable taking a value of 1 if the secondary school attended by a secondary-completer, and the primary school attended by a primary-completer, was a government school, and 0 otherwise
W = earnings per month
L = years of employment experience, directly measured
U, V = disturbance terms, with U assumed to be uncorrelated with V.

Equation (1) is an educational production function, similar in form to those used in most such studies surveyed by Hanushek, 1979 and Lau, 1979); estimates are presented in Table 1. In each country cognitive skill bears a highly significant positive relationship to educational level and to ability. In Kenya, secondary education raises cognitive skill by 11·75 points or by 35% at the means; similar results are obtained in Tanzania. The elasticity of response of cognitive skill to reasoning ability at the means is roughly 0·4 in both countries. Because the number of years that have elapsed since the respondent left school is a proxy for change in the quality of schooling over time and for gain or loss of cognitive skill after leaving school, the sign of its coefficient cannot be predicted. In neither country was the coefficient on T significantly different from zero, and the term was therefore deleted from the estimated equation. In both countries the coefficient on B is almost significantly negative, suggesting that urban birth, and by implication urban education, reduces cognitive skill. This counter-intuitive result may reflect greater selectivity in access to schooling and to the urban labour market among the rural-born, who face stiffer competition, rather than better quality of rural schools. In Kenya the coefficient on G is significantly positive, in accord with our expectation that government schools are on average of higher quality than private schools in Kenya.

In our model for the determination of inputs in the educational production, reasoning ability is exogenous and secondary-school attendance is influenced by reasoning ability and by the availability of secondary school places, which is exogenous. Educational attainment functions have been estimated for the samples by means of probit analysis (Boissiere *et al.* 1985).[1] In both countries

[1] Tests of recursiveness relating this equation to our equations (1) and (2) failed to reject the null hypothesis that the equation system is recursive.

Table 1

Kenya and Tanzania: Educational Production Functions

Variable	Kenya	Tanzania	Pooled sample
S Secondary schooling	11·754	10·939	11·611
	(8·50)	(8·84)	(12·07)
G Government school	3·366	0·995	2·475
	(2·49)	(0·76)	(2·53)
B Urban birth	−3·567	−2·651	−2·868
	(1·78)	(1·82)	(2·31)
R Reasoning ability	0·570	0·487	0·519
	(5·55)	(5·58)	(7·47)
K Kenya			7·712
			(8·45)
Constant	15·49	12·34	9·903
R^2	0·42	0·44	0·56
Standard error of *H*	8·77	7·76	8·45
Percentage standard error of *H*	21·1	26·2	23·5
N	205	179	379

Notes

(1) The dependent variable is *H*, cognitive skill.

(2) The figure in parentheses beneath a coefficient is its t statistic.

(3) The *H* variable was marked out of 61, there being a maximum of 28 in the literacy test and 33 in the numeracy test; the maximum score for *R* was 36.

(4) The dummy variable *K* represents membership of the Kenya sample, the base subcategory being membership of the Tanzania sample.

(5) A log-linear specification: ln *H*, ln *R* and ln *Y* replacing *H*, *R* and *Y* was also estimated but was inferior in terms of the percentage standard error of *H* (24% in Kenya and 31% in Tanzania), and the significance of some coefficients.

(6) The White heteroskedasticity test (White, 1980) cannot reject the null hypothesis of homoskedasticity of the errors. The White standard errors, i.e. standard errors which are consistent even in the presence of unknown heteroskedasticity, are very similar to the reported standard errors, and in no case does a coefficient cease to be significant when the White standard error is substituted.

the probability of going to secondary school increases significantly with reasoning ability and with the size of the secondary relative to the primary system at the time that primary schooling was completed. Ability thus influences the acquisition of cognitive skills both directly and indirectly through access to secondary education. The main difference in educational attainment between the two countries is due to the difference in the size of their secondary school systems, which in turn can be attributed to differences in government policies. The findings are consistent with the views that in Kenya, with its large private as well as government system, the market for secondary education is in equilibrium, whereas in Tanzania there is excess demand for secondary school places. Estimates of private rates of return to secondary education and subjective responses to survey questions also suggest excess demand in Tanzania (Knight and Sabot, 1986).

Equation (2), the semi-logarithmic earnings function, includes *H*, *R* and *S* among the independent variables to separate the positive effects on earnings of cognitive skill acquisition and reasoning ability from that of secondary school attendance. The first can be taken to represent the effect of human capital, and

Table 2

Kenya and Tanzania: Earnings Functions

Variable	Kenya	Tanzania
R Reasoning ability	0·006	0·0008
	(1·150)	(0·145)
S Secondary schooling	0·192	0·112
	(2·469)	(1·417)
H Cognitive skill	0·020	0·013
	(6·177)	(3·218)
L Employment experience	0·045	0·055
	(9·842)	(10·060)
Constant	5·476	5·726
R^2	0·440	0·425
Standard error of ln *W*	0·405	0·419
N	205	179

Notes

(1) The dependent variable is ln *W*, the natural logarithm of earnings.

(2) The figure in parentheses beneath a coefficient is its t statistic.

(3) The L^2 term in the specification was deleted from the estimated regression because its coefficient was not significant in either case.

(4) The White heteroskedasticity test (White, 1980) rejects the null hypothesis of homoskedasticity of the errors in the case of Kenya but fails to do so in the case of Tanzania. However, the White standard errors are very similar to the reported standard errors in both countries, and in no case does a coefficient cease to be significant when the White standard error is substituted.

the second the effect of individual ability on earnings. The coefficient on *S* is a ragbag that could represent 'credentialism', i.e. payment for secondary education irrespective of its productive effects, or the use of schooling as a statistical screening device for unobserved characteristics, or preschool human capital formation, or non-cognitive human capital traits acquired in school. Employment experience is a proxy for post-school skill acquisition, the normal expectation being that the earnings-experience profile has an inverted-U shape, namely $b_4 > 0$ and $b_5 < 0$.

Estimates of equation (2) are reported in Table 2. The coefficient on the experience term is positive and highly significant. School attendance has a positive effect on earnings, this effect being statistically significant in Kenya but not in Tanzania. The coefficient on reasoning ability is not at all significant in either country: reasoning ability has only an indirect effect on earnings through the access to, and the skills acquired in, secondary school. By contrast, the coefficient on cognitive skill is positive and significant at the 1% level in both countries. An extra point scored in the cognitive skill test raises earnings by 2·0% in Kenya and by 1·3% in Tanzania. The importance of cognitive skill in explaining earnings provides support for the human capital explanation of the correlation between schooling and earnings. It also suggests that the higher earnings of the more educated largely represent higher productivity – a conclusion also reached from the more detailed analysis in Boissiere *et al.* (1985).

A Chow test indicates that the earnings functions differ significantiy between

the two countries. In particular, the return to cognitive skill is lower in Tanzania than in Kenya (Table 2), despite Kenya's greater endowment of cognitive skill. This finding suggests that the production function is more efficient in Kenya, that such other factors as physical capital are relatively more abundant in Kenya, or that government pay policy depresses the return to cognitive skill in Tanzania.

Each type of explanation is plausible; each is examined in Knight and Sabot (1984). The Kenya economy is commonly thought to be more efficient owing to advantages in management, market size, capacity utilisation and availability of inputs. This efficiency could have implications for the marginal product of educated relative to uneducated labour. The structure of the urban economy might also raise the relative demand for educated labour in Kenya. But evidence from the surveys does not confirm this hypothesis: we find a close similarity in skill-based occupational composition of the two full samples. The percentages of employees in the main occupational groups in Kenya and Tanzania respectively are: managerial and supervisory 10·9, 12·3; clerical 31·7, 33·4; skilled manual 23·1, 21·3; semiskilled manual 16·3, 16·3; unskilled manual 18·0, 16·6.[1] The similarity of occupational structure suggests that the demand for cognitive skill in relation to unskilled labour does not differ between the two urban economies on account of their structural characteristics. Moreover, simulations with complex earnings functions, estimated using the full samples, fail to reject the null hypothesis that the relative demand functions are the same in the two countries. In support of the second explanation, there is institutional evidence and evidence from the full samples of an egalitarian pay policy in the public sector – both government and parastatal organisations – of Tanzania. However, using the tested subsamples, the introduction in equation (2) of a dummy variable representing employment in the public sector (P) and a 'public sector × cognitive skill' interaction term ($P \cdot H$) does not produce the hypothesised significant negative coefficient on the interaction term.[2] Whatever the reason for the difference in the return to cognitive skill, the important consideration is that the qualitative conclusions from the simulation analysis conducted below do not depend on whether the Kenya or Tanzania coefficient is used in the simulation.

Before combining the two functions, we test whether the estimated model is recursive – that is, whether the estimates are consistent and not subject to simultaneous equations bias. If some unmeasured characteristics, such as drive and determination, contributed both to cognitive achievement and to earnings, the error terms U and V would be correlated, as would cognitive skill and V. Applying a method developed by Hausman (1978), we added the predicted value of cognitive skill ($\hat{H}$) as an independent variable in (2).[3] In showing that,

[1] The criterion for occupational classification was the level of vocational skills of various kinds likely to be involved in a job. Classification was done by the researchers on the basis of job-description questionnaires completed during interview.

[2] Their introduction for Tanzania has negligible effects on the explanatory power of equation (2) and on the coefficients of the other variables, and yields the coefficients $+0{\cdot}036P$ and $+0{\cdot}002P \cdot H$ (their respective t values being 0·158 and 0·031). When interaction terms are added for all the independent variables ($P \cdot R$, $P \cdot S$, $P \cdot H$ and $P \cdot L$), the coefficient on $P \cdot H$ remains insignificant at $+0{\cdot}006$ (0·528).

[3] $\hat{H}$ is generated using (1) plus the other exogenous variables in the system.

for both countries, the coefficient is not significantly different from zero, we cannot reject the assumption that our equation system is recursive.[1]

III. EDUCATIONAL POLICY AND DIFFERENCES IN COGNITIVE ACHIEVEMENT

The average level of reasoning ability is much the same in the two countries: $\bar{R}_k = 27{\cdot}8$ and $\bar{R}_t = 26{\cdot}4$. Levels of cognitive skill are, by contrast, significantly higher in Kenya than in Tanzania. Kenya's mean scores are 23% higher on the literacy test and 44% higher on the numeracy test. With $\bar{H}_k = 40{\cdot}0$ and $\bar{H}_t = 30{\cdot}3$, the absolute difference in mean cognitive skill scores is 9.7. The regression results from the pooled sample in Table 1 indicate that, even after standardising for differences in characteristics, the mean cognitive skill score of Kenyans exceeds that of Tanzanians by 7·7. However, a Chow test rejected the null hypothesis that the educational production functions of the two countries are the same. This is therefore not the best estimate of the part of the difference in cognitive skill due to differences in educational production functions. We measure this difference by means of decomposition analysis.

Given that the mean cognitive skill of Kenyans is determined by the linear educational production function $\bar{H}_k = f_k(\bar{\mathbf{x}}_k)$ – where $\bar{\mathbf{x}}_k$ are the mean values of the set of independent variables – the mean value of cognitive skill that Tanzanians would achieve if the Kenya production function were to apply would be $f_k(\bar{\mathbf{x}}_t)$. The gross difference between the two countries is then decomposed as follows:

$$\bar{H}_k - \bar{H}_t = f_k(\bar{\mathbf{x}}_k - \bar{\mathbf{x}}_t) + [f_k(\bar{\mathbf{x}}_t) - f_t(\bar{\mathbf{x}}_t)] \tag{3}$$

or

$$\bar{H}_k - \bar{H}_t = f_t(\bar{\mathbf{x}}_k - \bar{\mathbf{x}}_t) + [f_k(\bar{\mathbf{x}}_k) - f_t(\bar{\mathbf{x}}_k)]. \tag{3'}$$

The former term shows the component explained by differences in the proportion of workers with secondary education and in the mean values of the other explanatory variables. The latter term – the residual – can be interpreted as a measure of the difference in the 'quality' of education, in the sense that output per unit of inputs is higher in one country than in the other.

As expected, inter-country differences in the explanatory variables other than educational attainment contribute little to the explanation. According to whether the Kenya or Tanzania educational production function is used, differences in the quantity of secondary education account for 15 or 14% of the gross difference respectively. This reflects the fact that the proportion of secondary-completers in the full sample total of primary- and secondary-completers is greater in Kenya ($\bar{S}_k = 0{\cdot}532$) than in Tanzania ($\bar{S}_t = 0{\cdot}414$). However, the residual accounts for no less than 75 or 78%. For given mean values of the explanatory variables, the predicted cognitive skill score using the Kenya educational production function greatly exceeds that using the Tanzania function as predictor.

This result suggests that country differences in the quality of education are

[1] The coefficients on $\hat{H}$ are $-0{\cdot}012$ and $+0{\cdot}012$, and their t statistics 0·861 and 0·970, in Kenya and Tanzania respectively.

an important determinant of cognitive achievement. We equate the residual with differences in quality, although we recognise that differences in the incentive systems in the two countries could produce different drive and family support, and that these might contribute to the residual. The lower quality of education in Tanzania could stem from divergences in educational policy. For example, although expenditures per pupil are roughly the same in the two countries, greater stress has been placed on curriculum diversification in Tanzania, perhaps at the cost of time spent on general academic skills, and on Kiswahili at primary school, perhaps at the cost of efficient learning in English at secondary school (Cooksey and Ishumi, 1986).

IV. THE SIMULATION METHODOLOGY

The two functions can be used together for simulation purposes to answer the following counterfactual questions. First, what is the effect on the average cognitive skill of the Tanzania labour force of increasing the quantity of education to the Kenya level? Secondly, what is the effect on the average cognitive skill of the Tanzania labour force of increasing the quality of education to the Kenya level?

To answer the first question, we substitute the Kenya for the Tanzania (full sample) mean value of the secondary school dummy variable, and predict the cognitive skill score using the Tanzania educational production function:

$$\hat{H}_t = a_{0_t} + a_{1_t} R_t + a_{2_t} S_k + a_{4_t} B_t + a_{5_t} G_t. \tag{4}$$

To answer the second question, we substitute the Kenya for the Tanzania educational production function and predict the cognitive skill score using the Tanzania mean values of the independent variables:

$$\hat{H}_t = a_{0_k} + a_{1_k} R_t + a_{2_k} S_t + a_{4_k} B_t + a_{5_t} G_t. \tag{5}$$

Further counterfactual questions can then be posed: what is the effect on average earnings in Tanzania if, in turn, the quantity, the quality, and the quantity and quality of education in Tanzania are increased to the Kenya level? The answer requires that the mean cognitive skill score resulting from each of these counterfactual changes in educational policy be substituted for actual cognitive skill in the Tanzania earnings function to predict the consequent change in mean earnings:

$$\ln \hat{W}_t = b_{0_t} + b_{1_t} S_{t,k} + b_{2_t} R_t + b_{3_t} \hat{H}_t + b_{4_t} L_t, \tag{6}$$

with the subscript to S being either k or t, as will be explained below.

The assumptions implicit in these exercises should be recognised explicitly. The simulations assume that the policy changes do not affect the coefficients of the functions nor the mean values of the other independent variables. It is also assumed that, reflecting the rationing of secondary places in Tanzania, there would be an effective demand for the simulated increases in the supply of secondary places.

V. CROSS-COUNTRY POLICY SIMULATIONS

Our results suggest that more literate and numerate workers are more productive. Tanzania may thus have paid a price in output foregone by restraining the growth of secondary education and reducing the quality of education for the sake of other goals. Our next exercise is to quantify this price by simulating the effect on wages, and thus on productivity, of differences between the two countries in the quantity and quality of education.

The results of our simulation exercises are presented in Table 3. The base runs use the actual values of both variables and coefficients; the predicted and actual mean levels of cognitive skill and of earnings are therefore the same. Simulation 1 shows the effect of the difference in quantity, simulation 2 the effect of the difference in quality, and simulation 3 the effect of simultaneous changes in quantity and quality. The Tanzania simulations introduce parameters from Kenya, and the Kenya simulations parameters from Tanzania.

An increase in the quantity of secondary education in Tanzania to the Kenya level would, on the basis of equations 1 and 2, increase the mean cognitive skill of the wage-labour force by 4% and mean earnings by 3% (simulation 1). An increase in the quality of education would increase cognitive skill by 24% and earnings by 10% (simulation 2). And a simultaneous increase in quantity and quality would increase cognitive skill by 29% and earnings by 13% (simulation 3).

Do these increases in predicted earnings also measure the increase in the productivity of employees? They are the result of assuming increases in the predicted mean value of cognitive skill H and in the proportion of secondary-completers S. The effect on earnings of the rise in H can only be interpreted as representing a productivity relationship. Although the coefficients on S could reflect unmeasured human capital acquired in secondary school, it might instead reflect credentialism, screening for ability, or pre-school human capital. If so, the rise in S would make no contribution to productivity. Simulations 1*a* and 3*a* differ from simulations 1 and 3 only in that the value of S in the other country is not substituted in the earnings function. They therefore show the lower-bound estimate of the effect on productivity of expanding secondary education in Tanzania to the Kenya level, assuming that the coefficient on S contains no productivity element. The quantity effect on productivity falls by less than half (compare simulations 1 and 1*a*) and the combined quantity and quality effect falls by 1·5 percentage points to 12% (3 and 3*a*). The interpretation of the coefficient on secondary education in the earnings function has little influence on the predicted change in productivity which results from introducing Kenya educational policy in Tanzania.

These simulations suggest that the opportunity costs to Tanzania of constraining the quantity and quality of education are substantial. The mean wage of the Kenya subsample was 41% higher than that of Tanzania, when converted at the official exchange rate; it would be higher if calculated on the basis of purchasing power parity. In 1971, before the effects of the divergent educational policies were manifested in the labour market, the mean urban

Table 3

Kenya and Tanzania: The Effect of Varying the Quantity and Quality of Education on Cognitive Achievement and on Earnings: Policy Simulations

	Kenya						Tanzania					
		Simulation						Simulation				
	Base run	1	1a	2	3	3a	Base run	1	1a	2	3	3a
Educational production function												
Mean values												
S Secondary schooling	0·532	0·414	0·414	•	0·414	0·414	0·414	0·532	0·532	•	0·532	0·532
R Reasoning ability	27·816	•	•	•	•	•	26·434	•	•	•	•	•
B Urban birth	0·110	•	•	•	•	•	0·190	•	•	•	•	•
G Government school	0·700	•	•	•	•	•	0·730	•	•	•	•	•
Coefficients												
S Secondary schooling	11·754	•	•	10·938	10·939	10·938	10·939	•	•	11·754	11·754	11·754
R Reasoning ability	0·570	•	•	0·487	0·487	0·487	0·487	•	•	0·570	0·570	0·570
B Urban birth	−3·567	•	•	−2·651	−2·651	−2·651	−2·651	•	•	−3·567	−3·567	−3·567
G Government school	3·366	•	•	0·995	0·995	0·995	0·995	•	•	3·366	3·366	3·366
Constant	15·490	•	•	12·340	12·340	12·340	12·340	•	•	15·490	15·490	15·490
Predicted cognitive skill												
Mean $(\hat{H})$	39·562	38·175	38·175	32·111	30·820	32·820	29·964	31·255	31·255	37·202	38·589	38·259
Change in mean $(\Delta\hat{H})$	—	−1·39	−1·39	−7·45	−8·74	−8·74	—	1·29	1·29	7·24	8·63	8·63
Percentage change in mean $(\Delta\hat{H})$	—	−3·5	−3·5	−18·8	−22·1	−22·1	—	4·3	4·3	24·2	28·8	28·8
Earnings function												
Mean values												
S Secondary schooling	0·532	0·414	•	•	0·414	•	0·414	0·532	•	•	0·532	0·414
R Reasoning ability	27·816	•	•	•	•	•	26·434	•	•	•	•	•
L Employment experience	9·026	•	•	•	•	•	7·163	•	•	•	•	•
H Cognitive skill	39·562	38·175	38·175	32·111	30·820	30·820	29·964	31·255	31·255	37·202	38·589	38·589
Coefficients												
S Secondary schooling	0·1924	•	•	•	•	•	0·1125	•	•	•	•	•
R Reasoning ability	0·0058	•	•	•	•	•	0·0008	•	•	•	•	•
L Employment experience	0·0448	•	•	•	•	•	0·0550	•	•	•	•	•
H Cognitive skill	0·0197	•	•	•	•	•	0·0129	•	•	•	•	•
Constant	5·4757	•	•	•	•	•	5·7261	•	•	•	•	•
Predicted earnings†												
Mean $(\hat{W})$	1014	966	987	876	835	854	717	738	728	787	812	801
Change in mean $(\Delta\hat{W})$	—	−48	−27	−138	−179	−160	—	21	11	70	95	84
Percentage change in mean $(\Delta\hat{W})$	—	−4·8	−2·7	−13·6	−17·6	−15·8		2·9	1·6	9·7	13·2	11·7

• Figure as for base run.

† Since the dependent variable in the earnings function is logarithmic, 'predicted mean earnings' is a geometric mean.

wage in Kenya was only some 10% higher. A third of the current difference in predicted mean wages converted at the official exchange rate (95 in relation to 297 shillings) can be explained by the lower mean cognitive skill of Tanzania employees.

It is reassuring that similar results are obtained when the simulations are conducted on the Kenya subsample (Table 3). The quantity effect on productivity is 5%, the quality effect 14%, and the combined effect 18%. Reinterpretation of the coefficient on secondary education in the Kenya earnings function reduces the change in productivity by less that 2 percentage points. The main contrast is that an even higher proportion of the difference in predicted mean wages (60%) can be explained by the higher mean cognitive skill of the Kenya workers. Even if the use of a purchasing-power-parity conversion factor were to reduce these percentages, the difference in cognitive skills would remain important.

As a guide to the potential gains from improving the quantity and quality of education in Tanzania, these estimates are liable to be biased in various respects. First, they take no account of diminishing returns to large increases in the supply of cognitive skills relative to other inputs. We have used the Kenya and Tanzania surveys to estimate the elasticity of relative earnings with respect to relative educational expansion, the inverse of the elasticity of substitution between educational levels (Knight and Sabot, 1984). Our estimate is that an increase in the Tanzania ratio of secondary- to primary-school leavers in the wage-labour force to the Kenya level reduces the ratio of their earnings by some 10%; the predicted gain in labour productivity would be little affected by diminishing returns. This result squares with our finding that the returns to cognitive achievement are not significantly lower in the manual occupations, which would absorb much of the additional supply of high cognitive achievers, than in the white-collar occupations, where they are now concentrated in Tanzania (Boissiere *et al.* 1985). Secondly, the fact that access to secondary schooling is fairly meritocratic implies that the expansion of secondary enrolment in Tanzania would reduce the qualifications of entrants to the secondary system. It also implies that our simulations overestimate the increase in productivity from educational expansion.

Thirdly, any upward bias in the estimate resulting from the above considerations may be offset by the downward bias that would result if our specifications had failed to capture the depressing effect of pay policy on the return to cognitive skill in Tanzania. Although the relative supply of cognitive skills is greater in Kenya, the return to them is higher. As a consequence, when the Kenya earnings function instead of the Tanzania one is used to measure the effect of changing the quantity and quality of education, it produces a change in earnings which is over 4% greater (Table 3). A further reason for expecting downward bias in the estimate of productivity increase stems from the way of selecting the subsample. Those who acquired most cognitive skill in secondary school were most likely to have continued their education beyond form IV and would therefore be excluded from the tested subsample.

Finally, although it is very plausible that higher cognitive skill commands

higher earnings because it raises the productivity of labour, only under the rigorous assumptions required for marginal product to equal wage will the increase in productivity equal the increase in earnings. However, there may be a direct proportional relationship. For instance, monopoly in the product market may depress the wage below marginal product, or marginal product may fall short of the wage if public sector employment exceeds the most profitable level. We cannot therefore claim that the predicted absolute increase in average earnings in Tanzania precisely measures the absolute increase in average labour productivity, but the percentage increases are likely to be similar.

VI. CONCLUSIONS

The project design has been comparative – first, to establish what relationships are robust, secondly, to explain such differences in relationships as are to be found between the two countries, and thirdly, to illuminate an issue on which policies in otherwise similar countries have differed greatly. Two findings, significant not only because they pass the usual statistical tests but also because they hold in both countries, are the positive effect of secondary education on cognitive skills and the positive effect of cognitive skills on earnings. They support the interpretation of the relation between secondary education and earnings as showing the effect of human capital acquisition in school on productivity at work. The observed differences in relationships and in parameters also assist the analysis. The difference in educational production functions permits identification of the effects of educational quality; the difference in mean secondary school attendance, the effects of educational quantity. The recursive model, estimated in the same way in the two countries, makes possible cross-country productivity-accounting analysis of the effects of education.

Kenya and Tanzania differ considerably in the quality of (secondary and pre-secondary) education and the quantity of secondary education. The cognitive skill of urban wage-employees with the same ability and school attendance is substantially higher in Kenya. Secondary enrolment rates and the level of education of the urban wage-labour force are also higher in Kenya. Consequently, the mean level of cognitive skill per urban wage-employee – and therefore mean earnings and productivity – is far higher in Kenya. Our simulations suggest that if the quantity and quality of education in Tanzania were raised to that of Kenya, the mean earnings of Tanzania urban wage-employees would be 13% higher. Since their productivity is likely to rise by a similar percentage, the economic benefits to Tanzania from pursuing such a policy would be substantial. The differences between the two countries in educational policy regimes appear to have been an important factor in their diverging mean wage and productivity of urban labour.

The difference in labour productivity attributable to the difference in policies for secondary education is likely to grow over time. The educational composition of the urban wage-labour force in 1980 did not fully reflect the divergence in policies which emerged in the 1970s. The proportion that secondary-

completers constituted of the combined group of primary- and secondary-completers for the sample as a whole was still only moderately higher in Kenya (where it was 0·53) than in Tanzania (0·41). For this reason the effect of simulating a rise in the quantity of secondary education in Tanzania to the Kenya level was modest, raising labour productivity in the urban wage sector by 3%. However, the difference in the proportion (0·27) for the cohort which had entered the market within the previous six years was more marked (the proportion being 0·65 in Kenya and 0·38 in Tanzania). If the present policies continue, the ensuing change in the educational composition of urban wage-employment will increase the difference in the proportion of secondary-completers in the relevant labour force and so increase the difference in labour productivity attributable to secondary education.

There are limits to the policy implications of results obtained for urban wage-employees in countries with predominantly rural economies. Nevertheless, since additional secondary school graduates would almost certainly be employed in the urban wage sector, it would seem that Tanzania could benefit substantially from an improvement in the quality of its education and quantity of its secondary education towards the Kenya level. There are reasons why the estimates made in the simulation analysis may be biased and why our results must therefore be regarded as suggestive rather than conclusive. Nevertheless, they have been obtained whilst avoiding some of the drawbacks that normally underlie output accounting or growth accounting analyses of the contribution of education. The greater similarity of the two urban wage economies and the greater comparability of our data have permitted somewhat more realistic simulation exercises than are normally feasible in cross-country output accounting studies. And through the introduction and measurement of cognitive skills as a link between education and earnings, it has been possible to answer questions of causality that others have simply had to beg.

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