Pergamon

0305-750X(94)00061-1

Education, Experience and Earnings in the Labor Market of a Developing Economy: The Case of Urban Khartoum

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Summary. — This paper examines the relevance of the human capital approach to explaining the variance in workers' productivity and earnings in the labor market or urban Khartoum. The analysis produces two principal findings. First, the rate of return to education in Sudan is relatively low compared with the rate of return in other developing countries, perhaps a reflection of poor quality of education in the Sudan. Second, while returns to primary education are lower than average, returns to college education are higher. This creates an interesting paradox because the Sudan educates a higher percentage of children at the secondary and tertiary levels than most sub-Saharan African countries. The most likely explanation is that the emigration of skilled manpower to other Arab States, combined with an influx of unskilled labor into Khartoum, has created a situation where skilled manpower is relatively scarce. The paper also examines the temporal relationship between education and the labor market and identifies how Sudan's rapid expansion of the education system has led to the filtering down of the educational qualifications and job competition, a process that may well stimulate dynamic growth throughout the economy.

1. INTRODUCTION

The potential contribution of education to improving labor productivity, lowering income inequality and promoting growth and development is well recognized, and virtually all governments allocate a considerable share of their budgets to public expenditure on education. For capital-scarce sub-Saharan Africa, the effective training and utilization of its human resources may be the essential ingredient for initiating successful development. It is somewhat disconcerting, therefore, to realize that despite impressive gains in the 1960s and 1970s, Africa's education system is showing signs of strain and primary education enrollment rates in several sub-Saharan African countries have recently stagnated or even declined (World Bank, 1988).

The reasons for the poor performance of the education sector are both fiscal and demographic. Regional economic malaise has reduced public expenditures on education, both absolutely and as a percentage of GNP in many countries. In addition, while mortality and fertility rates fell substantially in Latin America and Asia during 1965–85, only mortality declined in Africa; fertility remained relatively stable, well above a level required to replace the population. Consequently, the region experienced very high rates of population growth that were not matched by a similar expansion of resources for education. Currently, African governments spend very little per student on educational materials; on average, $0.60 per year, when a minimum of $5.00 is essential (World Bank, 1989, pp. 77–78). Finally, the downward trend in education may be partly attributable to a growing disillusionment among parents over the quality of education being offered and its usefulness, given the diminish-

ing prospects of obtaining employment in the formal sector upon graduation.

There is an enormous literature devoted to estimating rates of return to schooling and on-the-job training, but there are few empirical studies from sub-Saharan Africa. This paper helps to fill this vacuum by utilizing data recently collected by the authors in a survey of the Khartoum labor market. The standard human capital model is tested and peculiar results are derived: First, the overall returns to education in Khartoum are very low; second, there are increasing returns at higher levels of schooling — precisely those levels which have experienced the greatest expansion. These paradoxical results are then explained via an in-depth exploration of the operation of the urban formal sector labor market.

The plan of the paper is as follows: Section 2 presents a brief introduction to the country of Sudan, its labor market and its educational system. Section 3 reviews the basic human capital wage model, which is subsequently estimated in Section 4. Section 4 also evaluates the importance of credentialism in inflating the rate of return to education. Section 5 provides an exploration of the relationship between time of entry into the labor force and earnings in order to explain our empirical findings. The main conclusions of the analysis are summarized in Section 6.

2. COUNTRY SETTING AND DATA

Since 1970, Sudan's educational system has consisted of six years of primary school, followed by three years of intermediate school, followed by three years of secondary school with the possibility of university or tertiary training. Education is essentially free, although parents are expected to pay some minor fees and furnish children with books, writing materials and a uniform. These are often enough to prevent the poorest families from sending their children to school.

Sudan's educational system has expanded rapidly over the last three decades, but in an unusual manner. The growth of the secondary sector has been exceptionally rapid, and has occurred at the expense of the other sectors, notably the primary sector. Primary enrollment rates in Sudan are low compared with other sub-Saharan countries while secondary school enrollments in Sudan are higher than most other sub-Saharan African countries (World Bank, 1990, Table 29, p. 234). The rapid growth of secondary education has raised serious questions as to its appropriateness. Furthermore, the Government recently announced the proposed opening of five new universities. This move appears at odds with the stated aim of universal primary education by the year 2000, a goal that now appears unattainable.

Since the 1970s, many sub-Saharan African countries, including Sudan, have faced a worsening economic crisis. Growth in GNP per capita may have actually been zero over 1965–88 (World Bank, 1990). General symptoms of the economic malaise include: declining productivity in agriculture and industry, increasing fiscal and external debt, a shortage of foreign exchange, and high inflation. These problems have been exacerbated in Sudan by the legacy of a long civil war as well as a series of natural catastrophes including drought and floods. One casualty of the economic crisis has been wage levels in the formal sector which have fallen dramatically. Public sector real wages currently stand at 60–70% of 1978 levels (Fallon, 1994). Pay scales have also been compressed so that the ratio of skilled workers' pay to unskilled workers' pay has fallen considerably.

The most interesting feature of the Sudanese labor market is that it is characterized by an unusually high degree of labor mobility. The weak Sudanese economy has encouraged a growing number of Sudanese to seek employment abroad, mainly in the oil-exporting countries in the Gulf where they earn six to 15 times their potential salary in Sudan. These workers are disproportionately highly skilled and professional workers, and their departure has left local labor markets oversupplied in unskilled labor and suffering from a shortage of skilled manpower. In addition, the country has accepted large numbers of refugees from Ethiopia and other neighboring countries many of whom prefer to filter into the local economy than to remain in government-run refugee settlements. In 1986, the government estimated that 45,000 refugees had settled in the Khartoum area where they compete with local Sudanese for a limited number of urban jobs (ILO, 1987, p. 162). The consequences of such large redistributions of manpower for the wage structure in Sudan will become apparent later in this paper.

The data for this study are drawn from the Khartoum Employment Survey and are restricted to formal sector employees. The survey was conducted by the authors in 1989 on an establishment basis and deliberately oversampled the private sector. While the latter is believed by Fallon (1994) to constitute only about 16% of total formal sector urban employment, we suspected greater variation in the structure of earnings and the characteristics of its employees than in the public sector, which enjoys administered pay structures and formalized rules of promotion according to experience. The data were subsequently weighted so that correct inferences could be drawn.

Since no complete listing of formal sector establishments with 20 or more employees exists in Khartoum, a sampling frame was pieced together from various sources of information. Listings were obtained from Chambers of Commerce and business associations of various kinds and the enterprises were then stratified to the best of our knowledge by broad sector of activity. These were supplemented by *ad hoc* information about enterprises not on these lists. In

addition, public sector ministries and departments were added to the sampling frame, as were known parastatal organizations.

An added problem in selecting a representative sample of employees was that we did not know the underlying sectoral distribution of employment within the whole of the private sector, nor did we have much idea about the distribution of employment by occupation, sex, and age and size of establishments. As a result establishments on our lists were roughly stratified according to sector of activity, size (if known) and status (public/private/parastatal) and a random sample chosen. Enumerators were asked to make a complete listing of all employees in the selected establishments if one did not already exist. For businesses employing less than 200 workers, each employee was enumerated and basic information collected on his/her age, sex, education, vocational training, occupation, earnings and tenure in the firm. If more than 200 employees were engaged in the establishment, a stratified random sample of 200 was selected.

As a first step, means and standard deviations of the key variables are provided in Table 1. The mean number of completed years of school in the sample is 10.17, and 88% of the sample have received some form of formal education. Thus, the sample is considerably better educated than the general population, which averages 2.03 years of formal education, but this is as expected given that the survey was conducted in the nation's capital. Experience was approximated by age minus years of education minus six, which is the standard procedure for this type of analysis where precise data are unavailable. The mean amount of work experience in the sample is 19.14, and the mean age is 35.31 years.

Table 2 provides data on annual earnings by level of education and other selected worker characteristics. Mean annual earnings amounted to £S9,247.75. The official exchange rate at the time of the survey was £S4.5 = US$1, implying average annual earnings are slightly more than US$2,000. Unofficially, the black market rate was closer to £S12.1 = US$1,[1] implying mean earnings to be around US$764 per annum.

Labor legislation guarantees women equal pay for equal work, and protection against discrimination in employment and promotion. Men in Khartoum however, earn almost 25% more than women. Differences in the occupational distributions of men and women play a major role in explaining the earnings difference between the sexes (Cohen and House, 1993a). Women comprise only a small minority in most occupations. Almost half the women in the sample are confined to lower level white-collar jobs such as typists and clerks. At the same time, women tend to be grossly underrepresented in professional and managerial positions. There are also important differences in annual earnings among educational and experience groups, with workers with the most formal education enjoying a large advantage.

3. THEORETICAL FRAMEWORK

How do we explain these earnings differences, as

Table 1. *Means and standard deviations of variables in the sample*

Variable	Mean	Standard deviation
Age (AGE)	35.31	10.12
Male (SEX=1)	.76	.43
Years of schooling (SCH)	10.17	5.80
Years of experience (EXP)	19.14	12.20
Time in Khartoum (TIMEKHT)	23.37	14.01
Educational Level		
None (EDO=1)	.12	.33
1–3 Years (ED1=1)	.03	.18
4–6 Years (ED2=1)	.12	.33
7–9 Years (ED3=1)	.12	.32
10–12 Years (ED4=1)	.33	.47
13–15 Years (ED5=1)	.06	.23
16+ Years (ED6=1)	.22	.41
Earnings/month (EARNINGS)	177.84	167.78
Hours per week (HOURS)	45.36	8.25
Hourly wage rate (RATE)	4.01	3.91
Public sector employee (PUBLIC)	.83	.37
Ethiopian (ETHIOPIAN)	.01	.08
Foreign owned company (FOREIGN)	.02	.15
Number of observations	8037	

Source: Khartoum Employment Survey, 1989

Table 2. *Annual earnings by selected variables*

Variable	Annual earnings	Standard deviation	N
Sex			
Female	7,319.94	4,838.13	1,752
Male	9,853.45	9,547.61	6,285
Schooling			
None	5,260.71	2,384.16	1,143
1–3 Years	5,912.88	3,243.18	303
4–6 Years	6,782.51	3,296.89	1,191
7–9 Years	7,629.83	4,086.32	977
10–12 Years	7,760.30	5,782.28	2,570
13–15 Years	9,946.12	15,069.96	416
16+ Years	16,243.20	12,223.23	1,437
Experience			
< 5 Years	5,699.92	4,011.87	438
5–9 Years	7,241.43	5,321.83	1,672
10–14 Years	9,611.93	10,701.00	1,677
15–24 Years	11,071.59	10,565.15	2,115
25+ Years	9,334.50	7,271.12	2,135
Public sector employee			
Yes	9,241.41	6,229.76	4,537
No	9,279.43	16,209.49	3,500
Nationality			
Sudanese	9,268.19	8,740.14	7,919
Ethiopian	5,629.83	3,969.76	118
Total	9,247.75	8,724.82	8,037

Source: Khartoum Employment Survey, 1989

revealed in Table 2? Human capital theory provides the standard framework for examining the relationship between earnings and schooling (Becker, 1975; Mincer 1974). The standard form of the earnings function that is usually estimated is:

$$\ln(\text{RATE}) = \beta_0 + \beta_1 \, SCH + \beta_2 \, EXP + \beta_3 \, EXP^2 + \varepsilon \quad (1)$$

where $\ln(\text{RATE})$ represents the natural logarithm of the hourly wage rate, SCH represents completed years of formal education, EXP represents labor market experience, and ε is a well-behaved error term that captures other unobserved factors that are important contributory factors to labor earnings. Note the influence of schooling is modeled here as separable from the influence of experience. β_0 represents the entry-level wage to a new labor market entrant with no schooling, β_1 captures returns to schooling, while β_2 and β_3 are intended to capture returns to on-the-job training, which are assumed to be nonlinear because of diminishing marginal returns to increased on-the-job training and rising marginal cost of further training over time. It is expected that $\beta_0 > 0$, $\beta_1 > 0$, $\beta_2 > 0$, and $\beta_3 < 0$.

A number of econometric problems plague the basic model and have fueled an enormous debate over the degree to which the schooling coefficient (β_1) accurately reflects the private rate of return to investment. Many of the issues can be traced back to the validity of an initial set of simplifying assumptions that were introduced to lend mathematical tractability to the problem. These issues include, *inter alia*: (a) there is no control in the model for the quality of schooling; (b) all results refer only to wage employees; (c) the effects of schooling and experience should not be regarded as weakly separable; (d) the market should not be assumed to be in long-run equilibrium; (e) there is no correction for unobserved ability bias that is correlated with school attainment; (f) the amount of schooling may be measured with error; and (g) there are no controls for background variables such as parental education.[2]

As is often the case in the social sciences, the theoretical debate is advanced to a point where the requirements for adequately testing such models are considerable and far exceed the available data. This is certainly true in sub-Saharan Africa where any micro-level data on employment and earnings are

rare. In any event, there is less cause for concern regarding a schooling-ability bias in Sudan than in the United States: with so few workers attending higher education, not going to college reveals little about ability; put differently, there should be many very able, and very cheap, noncollege-educated workers. Given the exploratory nature of this analysis, it was decided to initially retreat from the intractable problem of attempting to control for unobserved ability and follow a well-established empirical literature by estimating equation (1) and its variants using ordinary least squares (OLS).[3]

4. ESTIMATION OF THE STANDARD FORM

The results of estimating the basic schooling and schooling-experience models are presented in Table 3. The top part of this table focuses on all workers, while the other two parts focus on men only and women only.[4] Our measure of productivity is the natural logarithm of the hourly wage rate. Four variants of the basic, semi-logarithmic, model are presented. In each specification, all coefficients take the expected signs and are significant at the 1% level. The basic schooling model (column 1) explains 32% of the variance in log earnings. The estimated rate of return to an additional year of schooling in the basic model is 6.0%, a figure that is slightly higher for men than it is for women. It is well established, however, that such an approximation is biased downward because it fails to correct for the possibility of further accumulation of human capital through on the job training, and, in any event, workers with higher education must, *ceteris paribus*, have less labor market experience. The standard human capital model

Table 3. *Regression results of hourly wage equation*

Independent variable	Dependent variable = ln(RATE)				Mean	S.D.
	(1)	(2)	(3)	(4)		
All Workers (N = 8037)						
SCH	.060 (.001)*	.093 (.001)*	.054 (.003)*	.041 (.005)*	10.17	5.80
SCH^2	—	—	.002 (.000)*	.002 (.000)*	137.14	114.38
EXP	—	.059 (.001)*	.057 (.001)*	.050 (.003)*	19.14	12.20
$EXP^2 \times 10^{-3}$	—	−.625 (.030)*	−.635 (.026)*	−.544 (.037)*	515.14	622.90
$(SCH \times EXP)10^{-3}$	—	—	—	.382 (.110)*	154.54	122.22
Constant	.563	−.585	−.413	−.277		
Adjusted R^2	.320	.576	−.589	−.589		
F-statistic	3787.41*	3639.17*	2874.17*	2304.90*		
Males (N = 6285)						
SCH	.064 (.001)*	.093 (.001)*	.055 (.003)*	.046 (.005)*	9.73	6.09
SCH^2	—	—	.002 (.000)*	.002 (.000)*	131.84	121.28
EXP	—	.056 (.002)*	.054 (.002)*	.049 (.003)*	21.05	12.47
$EXP^2 \times 10^{-3}$	—	−.573 (.029)*	−.584 (.029)*	−.517 (.041)*	598.65	662.99
$(SCH \times EXP)10^{-3}$	—	—	—	.282 (.120)*	163.22	130.52
Constant	.592	−.518	−.362	−.260		
Adjusted R^2	.371	.585	.597	.597		
F-statistic	3701.38*	2953.84*	2326.39*	1863.56*		
Females (N = 1752)						
SCH	.056 (.002)*	.092 (.002)*	.043 (.007)*	.029 (.012)	11.56	4.51
SCH^2	—	—	.002 (.000)*	.003 (.000)*	153.98	86.79
EXP	—	.066 (.003)*	.067 (.003)*	.058 (.007)*	13.06	8.88
$EXP^2 \times 10^{-3}$	—	−.854 (.076)*	−.968 (.076)*	−.846 (.117)*	249.33	362.20
$(SCH \times EXP)10^{-3}$	—	—	—	.460 (.334)*	126.89	85.20
Constant	.393	−.676	−.461	−.319		
Adjusted R^2	.249	.523	.535	.536		
F-statistic	579.16*	633.35*	505.47*	404.96*		

* Numbers in parentheses next to coefficient are standard errors. An asterisk denotes significance at the 1% level, two-tailed test
Source: Khartoum Employment Survey, 1989

as suggested by Mincer (1974) corrects for this source of bias by including experience and its square as explanatory variables. This specification (column 2) increases the overall explanatory power of the regression equation (adjusted-R^2) to .58. Thus, the variation in schooling and the variation in experience among workers contribute roughly the same to earnings inequality. The estimate of the rate of return to an additional year of schooling rises to 9.3% in this second specification, which is significantly less than Psacharopoulos (1985) reports for other African countries (13%).[5] This is a surprise because the level of development in Sudan is quite similar to Psacharopoulos's sample of other African countries and the rate of return to schooling generally follows the level of development quite closely.

The inclusion of a measure of labor market experience is intended to track the productivity enhancing effect of on-the-job training over the life-cycle. It also serves as a proxy for seniority which may in itself lead to higher earnings, but is not necessarily a guarantee of higher productivity. Training is assumed to be most cost-effective at the beginning of one's working life and, typically, earnings rise with the first 30 years of experience, diminishing thereafter. Column 2 in Table 3 reveals that an additional year of labor market experience is initially worth about 5–6% of additional income, with the return falling to zero around 47 years of experience. Two additional observations to make about the rate of return to experience are: the return to an additional year of on-the-job training exhibits diminishing returns, and the level corresponds quite closely to the rate of return to an additional year of schooling. Column 3 includes a squared term for schooling in an attempt to capture any nonlinearities in the rate of return to schooling on earnings. The positive coefficient on schooling squared indicates that the return to an additional year of schooling increases with each level of education. Moreover, column 4 demonstrates that the positive coefficient on SCH^2 remains even controlling for the interaction of schooling and experience (SCH × EXP). Thus, this is the second surprising finding of our analysis because it is widely found that the largest improvements in productivity occur during the early years of primary education (Psacharopoulos, 1985).

These results — the low overall rate of return to education and increases in the rate with rising education — are important paradoxes that need explanation because it is widely believed that the largest improvements in productivity occur during the early years of primary education. There are three plausible explanations for this usual pattern of the rates of return to education. First, if only the most able workers advance through the educational system, there could be an unobserved correlation between ability and schooling. There seems, however, little ground for

assuming that ability bias is more serious in Sudan than elsewhere. Second, certain qualifications could be rewarded over and above their true value. We show below that this is part of the explanation, but that it is unable to account for all the variance in earnings. Third, and we believe the most plausible explanation, is that emigration of skilled manpower to other Arab States, combined with an influx of unskilled labor into the areas, has led to a labor market where skilled manpower is relatively scarce.

In order to increase our understanding of the relationship between schooling and earnings more closely, we regressed our dependent variable, ln(RATE), on education and experience again, but this time we broke education into a set of dummy variables representing different educational levels. The results are presented in Table 4. Again, all variables take the expected signs and are significant at the 1% level. The estimated rate of return to an additional year of schooling is now obtained by dividing the difference between the coefficients of adjacent groups by their difference in years of schooling. The estimates are provided in Table 5. The exercise confirms that, indeed, the lowest returns to education in Khartoum are to the first few years of schooling, and the highest returns are to tertiary-level education and above (i.e. ED5 and ED6). This pattern is clearly visible in the male sample, whose influence spills into the total sample. The pattern is less obvious for women, except for women with over 16 years of education. Interestingly, an undergraduate degree or some other form of tertiary education does not appear to confer the same level of benefits on women as the equivalent qualification does for men. Again, the occupational segregation of roles is likely a large part of the explanation.

Establishing this usual pattern of rising rates of returns to higher education levels raises an important policy question: Are certain qualifications rewarded over and above years of education? The validity of the above analysis of the human capital model rests on the conventional assumption that education, measured by years of formal schooling, imparts various cognitive skills (literacy and numeracy) that increase productivity and raise the value of workers' time. An alternative explanation is that formal education is primarily used as a screening device by employers to select the most gifted workers. Do workers compete for the most lucrative jobs by collecting credentials merely to signal their abilities to employers? Under such a scenario, workers have an incentive to overeducate themselves and exaggerate their true abilities, and the private rate of return to education will exceed the social rate of return (Layard and Psacharopoulos, 1974).[6]

To investigate the extent of "credentialism" in the Khartoum labor market we performed two indepen-

Table 4. *Returns to schooling by type: Schooling-level specific earnings equations*

Independent variables	Dependent variable: ln(RATE)		
	Total sample	Males	Females
(ED0)			
ED1	.091 (.029)*	.098 (.032)*	.052 (.067)
ED2	.344 (.019)*	.335 (.020)*	.319 (.055)*
ED3	.616 (.020)*	.601 (.022)*	.607 (.049)*
ED4	.898 (.018)*	.893 (.020)*	.858 (.045)*
ED5	1.143 (.025)*	1.155 (.030)*	1.068 (.052)*
ED6	1.578 (.019)*	1.603 (.021)*	1.429 (.047)*
EXP	.059 (.001)*	.055 (.002)*	.068 (.031)*
$EXP^2 \times 10^{-3}$	−.673 (.027)*	−.607 (.030)*	−.997 (.078)*
Constant	−.431	−.364	−.481
Adjusted R^2	.560	.569	.521
F-statistic	1280.95*	1039.42*	238.94*
Mean of Dependent Variable	1.174	1.215	1.043
Sample size	8037	6285	1752

* Denotes significance at the 1% level, respectively. Numbers in parentheses next to coefficients are standard errors
Source: Khartoum Employment Survey, 1989

dent tests. First, various specifications of the basic earnings function were reestimated including a set of binary variables for different degrees of certification. The results of this exercise are given in Appendix A.[7] The analysis showed that the inclusion of a set of dummy variables for qualifications did little to improve the overall explanatory power of the model; the gain was a mere six percentage points in the variance in hourly log earnings on the simple human capital model presented in Table 3. Virtually all the dummy variables on individual qualifications, however, were positive and significant. Their inclusion also lowered the estimate of the rate of return to edu-

Table 5. *Private rates of return to an additional year of education (%)*

Educational level	Total sample	Males	Females
ED1 vs ED0	4.6	4.9	3.3
ED2 vs ED1	9.5	9.0	9.2
ED3 vs ED2	7.4	7.3	8.2
ED4 vs ED3	7.8	8.1	7.0
ED5 vs ED4	11.9	12.1	6.0
ED6 vs ED5	12.6	12.3	12.9

* Estimated rates of return to an additional year of schooling are obtained by dividing the difference between the two coefficients by the difference in midpoints of schooling intervals
Source: Khartoum Employment Survey, 1989

cation as measured by the size of the coefficient on years of schooling (SCH). These findings suggest that certain qualifications are rewarded over and above years of education.

As a second test for credentialism, we examined the distribution of workers by qualifications and each labor market segment. The hypothesis to be tested is that rigid entry qualifications prevent workers that dropped out of school before acquiring their qualifications from easily entering the formal sector where credentialism is assumed to be more prevalent. For this analysis, we compared the distribution of workers by their qualifications and labor market segment to similar data from an unpublished survey of Khartoum's informal sector that was conducted by one of the authors the following year. The results are reported in Table 6.

For all three levels of education shown (primary, intermediate, and secondary), the informal sector contains a higher percentage of dropouts than either the public or the private sectors. The largest single employer, the government, employs the lowest percentage of dropouts. Not surprisingly, without any direct measure of productivity, the public sector recruits and promotes on the basis of formal qualifications and experience. It is also clear from Table 6, however, that the large-scale private sector also screens workers on the basis of their qualifications and thus operates more like the public sector than the informal sector in this regard.

Table 6. *Distribution of workers who completed schooling by level of schooling and labor market segment*

Education	Public sector	Private large	"Informal Sector"	
			Employees	Entrepreneurs
Primary				
Dropout	24	25	43	44
Complete	76	75	57	56
Intermediate				
Dropout	5	8	15	10
Complete	95	92	85	90
Secondary				
Dropout	4	7	21	21
Complete	96	93	79	79

Source: Khartoum Employment Survey, 1989 and Khartoum Informal Sector Survey, 1989

In conclusion, the above tests suggest that an element of screening is present among employers in the formal sector labor market in Khartoum. Education appears to count for more than simply improved productivity.

5. EXAMINING THE EDUCATION– EXPERIENCE INTERACTION: FILTERING DOWN AND THE RETURNS TO EDUCATION

The validity of our estimates of the rate of return to education rests on the key assumption that the wage rate accurately reflect the marginal productivity of labor. This will not be the case when there are barriers that prevent labor markets from functioning competitively. These barriers may take a number of forms including, *inter alia*, minimum wage regulations, strong union activity, or a nonrationalization of market forces. If this is the case, earnings can simply reflect the sector or the occupation in which a worker is employed, although access to any sector may be partly determined by a worker's formal qualifications. In any case, labor market practices can contribute to inequality and possible inefficiency and the econometric issue becomes one of identifying the relative contribution of labor market practices versus human capital endowments in determining earnings. This is the topic to which we now turn.

Labor markets are continually responding to disequilibria created by the demand and supply of educated workers altering over the course of the development process. On the demand side, the development process in most countries begins with the emergence of a large, centralized public sector that provides the majority of a formal sector employment opportunities. Once an infrastructure and private markets emerge, the importance of the public sector as an employer diminishes. This change in the economy

leads to a change in the occupational structure — a proportionally lower demand for new administrative and clerical workers and an increase in the demand for skilled and semi-skilled blue collar workers, particularly in the manufacturing sector. Partly generating the above changes and partly as a result of these changes, an expansion of the school system alters the composition of labor supply, with each entering cohort of workers becomes more educated than the last. More important still, rapid population growth often leads to a large discrepancy between the size of each incoming cohort relative to the number of new jobs being created. The result is a growing disparity between the structure of the labor force and the structure of employment opportunities and the result is inevitably the "filtering-down" of educated workers into lesser skilled tasks, a process that may well stimulate dynamic growth throughout the economy. Consequently, occupation and the year of entry into the labor market may play a more central role in the urban wage determination process in African labor markets than previously thought (Knight, 1979; de Beyer and Knight, 1989; Knight and Sabot, 1990).

This theme is explored in this section of the paper in order to help explain the apparent Sudanese paradox of increasing returns to post-primary levels of education, precisely those which have experienced the greatest expansion.

Returning to Table 3, the final specification of the earnings equation (column 4) includes an interaction term between schooling and experience. The coefficient is positive and significant, indicating that the return to education depends on the length of employment experience, with more educated workers having the steeper earnings–experience profiles. In unreported equations separate earnings functions were estimated for each level of education.[8] These results highlight the interaction between education and experience with the most educated workers having the steepest earnings profiles, which confirms that treat-

ing schooling and experience as independent as suggested by earlier theory is inappropriate.

An interaction between education and experience has been found in other studies, but it is not predicted by either the simple human capital model nor by the screening hypothesis although both models are flexible enough to accommodate such a finding.[9] Probably education serves both a productivity-enhancing and labeling function, with the relative importance of each varying with the level of education and the type of curriculum studied. It is important to recognize, however, that rapid population growth and educational expansion has meant that the supply of educated workers has changed dramatically over time. Because of this, labor market conditions at the time of entry have worsened for each incoming cohort and the structure of employment has changed. Consequently, educated workers are now forced to "filter-down" into less-skilled jobs. This "filtering-down" process implies that the labor market is not in the kind of static equilibrium setting envisaged in the basic "schooling" model.

(a) The relationship between education and the labor market over time

In a cross-sectional data set, the age of a worker measures two separate effects. First, it provides a crude measure of labor market experience, which serves as a proxy for skills acquisition. Second, it defines the year of labor market entry. This is not a serious drawback for estimating the returns to experience in a competitive labor market that is virtually static over time. If the supply of educated workers has increased over time, however, the returns to experience are more likely to reflect the scarcity value of labor at the time of entry into the labor market than the gains to productivity acquired through labor market experience.

Evidence of the dramatic expansion of Sudan's school system is displayed in Table 7 which reports the mean years of schooling for formal sector workers by date of joining the labor force. Workers joining the

formal sector between 1956 (when the country received its independence) and 1960 averaged slightly more than six years of education, or the equivalent of a primary school education. Since 1971, the average worker joining the formal sector has completed secondary school (12 years); and, since 1981, the average requirements for formal sector employment have increased to include a full year of additional education beyond secondary school.

For many years the Sudanese Government operated a guaranteed employment program for secondary school leavers (the Employment Relief Program), which employed large numbers of school leavers even though staff expansion in the public sector was often unjustified on pure efficiency grounds. Thus not only did secondary school leavers in the past benefit from being scarce, as enrollment rates grew, they also enjoyed a government guarantee of lifetime employment. The employment program was gradually abandoned in the 1970s, first for secondary school leavers, then Arts graduates, then Science graduates and finally for Agriculture graduates. Currently, approximately 120,000 new secondary school leavers compete annually for about 5,000 new formal sector jobs which many leavers still view as their ultimate goal. The remainder either swell the ranks of the unemployed or are forced to seek an occupation in the informal sector where their skills may be underemployed.

To explore the extent of filtering down in Khartoum we estimate a multinominal logistic model of occupational attainment, and use it to predict the relative probabilities of an individual falling in one of the six broad occupational groups on the basis of his/her characteristics. These occupational groups were constructed to rank occupations on the basis of skill, and limit, as much as possible, movement between groups.

Included in the determinants of occupational choice are five variables measuring educational attainment, four measuring cohort effects, sex, time in Khartoum, and a dummy variable indicating whether the worker is Sudanese or an Ethiopian. It is expected that the more highly educated will favor the more skill-intensive jobs, hence at any given point in time,

Table 7. *Mean years of schooling by date of joining labor market: Formal sector employees in Khartoum*

Date joining	Total sample	Males	Females
1956–60	6.01 (.22)*	6.25 (.23)	4.19 (.54)
1961–70	9.85 (.15)	9.88 (.17)	9.65 (.34)
1971–80	12.24 (.09)	12.17 (.11)	12.43 (.12)
Since 1981	13.03 (.07)	12.94 (.11)	13.15 (.09)
Mean	10.17 (.06)	9.73 (.08)	11.56 (.10)

* Figures in parentheses are standard errors
Source: Khartoum Employment Survey, 1989

the effect of higher education is to increase the likelihood that the worker is in a skill-based occupation. Age is used as an imperfect proxy for date of entry into the labor force and, consequently, it is also positively correlated with occupational attainment. Furthermore, age proxies labor market experience which may itself be correlated with occupational attainment.

Maximum likelihood estimates of the parameters are presented in Table 8. Regrettably, interpretation of the coefficients is not as straightforward as linear regression because they convey information about the logarithm of the relative probabilities of being in one category relative to another. A quick way to interpret the results, however, is to simply rank the coefficients according to size. For example, by ranking the coefficients on sex from smallest to largest:

OCC3 — Junior white collar (e.g., clerk, typist)
OCC6 — Unskilled blue collar (e.g., cleaner, messenger)
OCC2 — Middle white collar (e.g., teacher, community worker)
OCC5 — Semi-skilled blue collar (e.g., factory worker)
OCC1 — Professionals/managerial (e.g., doctor, manager)
OCC4 — Skilled blue collar (e.g., carpenter, electrician)

One can see that, ceteris paribus, being female increases the likelihood that the worker is in any occupation higher on the list than any occupation lower on the list. Hence, the results confirm our expectations regarding occupational segregation of employment opportunities by gender. Females in such a traditional Muslim society as Sudan have very low status and tend to be confined to a narrow range of occupations, primarily one of three groups: clerical/secretarial jobs (OCC3); middle white collar jobs, e.g. nurses, primary school teachers, etc. (OCC2); and unskilled tasks such as cleaners and messengers (OCC6).

Similarly, higher formal education implies a higher probability that a worker is in a higher skill-based job. Comparing the coefficients on the education variables ED0 and ED56 across equations, it is evident that no education raising the probability of being an unskilled workers (OCC6) relative to all other occupation choices, and possession of tertiary level schooling raising the probability of being a professional/managerial white collar worker (OCC1), relative to all the other occupation categories.

In order to clarify the presentation and to demonstrate the way in which education and age jointly determine occupational outcome, the probabilities of an individual being employed in any of the six occupational groups have been calculated and are presented in Table 9.[10] Mean years of school rises consistently with the increase in skill intensity required in the various occupational groups. With little or no formal education, there is virtually a zero probability of obtaining a white collar job. At the other end of the spectrum, workers with more than secondary schooling are virtually guaranteed employment in a nonmanual occupation.

Table 9 also demonstrates how the filtering down of qualifications across occupations has occurred. Being older increases the likelihood of having an occupation higher up the skill ordering of occupations, despite the fact that the occupational groups were deliberately chosen to limit this happening as the result of greater experience. For example, although older workers have more experience and entered the labor market earlier than younger workers, it is highly unlikely that the experience that comes with age could facilitate a shift from nonmanual to manual occupations. From Table 9 we see that 68% of intermediate school leavers aged 55+ are employed in nonmanual occupations while only 42% of similar workers aged 35–44 and only 14% of similar workers under 25 have nonmanual occupations. These large changes in the distribution of workers by occupation can only be attributable to filtering down. Under today's labor market conditions, leaving school before completion of secondary education is no longer sufficient to guarantee a white collar job.

(b) Occupation as a factor in wage determination

The idea that the demographic composition of the work force may influence wage rates or other labor market outcomes has received a good deal of attention in the US-based literature.[11] Curiously, significantly less attention has focused on the effect of the changing size and composition of entering cohorts on labor market outcomes in less-developed countries where the problem is, seemingly, much more acute and growing over time.

To better understand the effect of occupation on the wage determination process, earnings functions are estimated for each occupational group and are reported in Table 10. The chosen earnings equation is an extended variant of Mincer's (1974) basic equation. The results of this exercise are quite satisfactory; although the proportion of the variance explained by the regressors varied between 41% (OCC3) and 17% (OCC6) of the variance, most coefficients took on the expected signs and were significant according to the standard criteria. Each regression was then compared in turn with every other, on a pairwise basis, using a standard F-test. (The results of this exercise are given in Appendix B.) Specification test statistics, according to these pairwise comparisons, were all significant at

Table 8. *Multinomial logit model of occupational attainment*
(excluded class: Unskilled blue collar workers, OCC6)

	Managerial white (OCC1)	Middle white (OCC2)	Junior white (OCC3)	Skilled blue (OCC4)	Semi-skilled blue (OCC5)
(ED4)					
ED0	−43.85	−6.91*	−8.45*	−2.46*	−1.50*
	(0.00)ˈ	(16.94)	(14.05)	(11.82)	(10.73)
ED12	−6.77*	−3.93*	−5.46*	−1.54*	−.69*
	(18.61)	(23.97)	(26.43)	(8.51)	(5.44)
ED3	−3.22*	−2.34*	−3.29*	−.96*	−.33*ⁱ
	(16.23)	(16.04)	(22.45)	(4.97)	(2.41)
ED56	5.90*	4.49*	3.06*	2.50*	2.04*
	(8.19)	(6.25)	(4.26)	(3.10)	(2.70)
(AGE3544)					
AGE<25	−3.94*	−2.12*	−1.65*	−1.49*	−1.12*
	(14.44)	(12.06)	(9.66)	(6.87)	(8.77)
AGE2534	−1.73*	−.88*	−.36*	−.60*	−.09
	(11.01)	(6.18)	(2.47)	(3.60)	(.81)
AGE4554	1.34*	.36	.55*	.46*	.25
	(6.46)	(1.90)	(2.59)	(2.53)	(1.89)
AGE55+	2.27*	.56*	1.43*	.61*	.30
	(7.53)	(2.02)	(4.77)	(2.59)	(1.62)
SEX	1.21*	.43*	−.30*	1.75*	1.11*
	(7.88)	(3.41)	(2.52)	(7.11)	(8.81)
TIMEKHT × 10⁻¹	.05*	.36*	.31*	.35*	.09*
	(9.30)	(7.90)	(6.85)	(7.28)	(2.73)
ETHIOPIAN	−2.20*	−2.61	−1.46*	−1.85	.70*
	(3.57)	(4.36)	(3.83)	(1.81)	(3.04)
Constantˢ	−.19	1.14	2.20	−2.03	−.60

Log of likelihood function = −8972.56
Chi-squared test statistic = 9531.57*
 N = 8037

* Significant at 1% level, two-tailed test
ˈ Figures in parentheses are t-statistics
ⁱ Significant at 5% level, two-tailed test
ˢ Constants have been adjusted for the choice-based sample by subtracting from each the logarithm of the ratio of the probability of inclusion in outcome *j* in the sample group to the probability of inclusion in outcome *j* in the population (Manski and Lerman, 1977)
Source: Khartoum Employment Survey, 1989

the 1% level, indicating that, as Knight and Sabot (1990) argue, each occupational group can be considered to have its own earnings equation.

6. CONCLUSIONS

This paper has examined the relevance of the human capital approach to explaining the variance in

Table 9. *Estimated probabilities of having job in occupation* i *

Education and Age	Nonmanual occupations			Manual occupations		
	OCC1	OCC2	OCC3	OCC4	OCC5	OCC6
No Formal Education						
Age < 25	.00	.00	.00	.02	.13	.84
Age 25–34	.00	.00	.00	.05	.29	.65
Age 35–44	.00	.00	.00	.09	.29	.61
Age 45–54	.00	.01	.00	.13	.33	.53
Age 55+	.00	.01	.01	.14	.33	.51
Primary Education						
Age < 25	.00	.02	.01	.06	.24	.68
Age 25–34	.00	.05	.02	.09	.42	.43
Age 35–44	.00	.09	.02	.14	.38	.36
Age 45–54	.01	.11	.04	.17	.39	.28
Age 55+	.03	.12	.07	.17	.36	.25
Intermediate Education						
Age < 25	.00	.08	.06	.08	.26	.52
Age 25–34	.02	.14	.11	.10	.37	.26
Age 35–44	.08	.23	.11	.12	.28	.18
Age 45–54	.20	.21	.12	.12	.23	.12
Age 55+	.32	.17	.19	.09	.15	.07
Secondary Education						
Age <25	.03	.23	.45	.06	.10	.14
Age 25–34	.09	.24	.50	.04	.08	.04
Age 35–44	.24	.29	.36	.04	.05	.02
Age 45–54	.44	.20	.30	.03	.03	.01
Age 55+	.52	.11	.33	.02	.01	.00
University Education						
Age <25	.26	.47	.23	.02	.01	.00
Age 25–34	.48	.33	.17	.01	.01	.00
Age 35–44	.72	.21	.06	.00	.00	.00
Age 45–54	.87	.09	.03	.00	.00	.00
Age 55+	.92	.05	.03	.00	.00	.00

* Probabilities calculated from estimated coefficients in Table 8 for a hypothetical male that has lived in Khartoum 23.18 years (equal to the sample mean of TIMEKHT), using the formula: $p_{ij} = \exp(x_i b_j) / \Sigma_{k=1,...,6} \exp(x_i b_k)$. All rows add to 1.00. Key: OCC1 = (1,0) Professional/Managerial Workers; OCC2 = (1,0) Middle White Collar Workers; OCC3 = (1,0) Junior White Collar Workers; OCC4 = (1,0) Skilled Blue Collar Workers; OCC5 = (1,0) Semi-Skilled Blue Collar Workers; OCC6 = (1,0) Unskilled Workers
Source: Khartoum Employment Survey, 1989

formal sector workers' productivity and earnings. It focuses on the role of education and labor market experience. The analysis has produced two main findings. First, the rate of return to education in Sudan is relatively low as compared with the rate of return in other developing countries, perhaps a reflection of poor quality of education in Sudan. Second, while returns to primary education are lower than average, returns to tertiary-level education are higher. This creates an interesting paradox since Sudan educates a higher percentage of children at the secondary and tertiary levels than most sub-Saharan African countries. The most likely explanation is that the emigration of skilled manpower to other Arab States, combined with

an influx of unskilled labor into Khartoum, has created a situation where skilled manpower is scarce and unskilled labor is abundant.

One of the most difficult tasks African manpower planners face is matching suitable employment opportunities with the structure of the urban labor force. The challenge is becoming increasingly acute as rising educational attainment and rapid population growth coupled with rural–urban migration combine to produce large numbers of young, more educated workers in urban centers. Sudanese planners, however, face additional challenges that include dealing with both the growing internationalization of the Sudanese labor force and the recent influx of refugees. These popula-

Table 10. *Estimated earnings equations for various occupational groups*

Dependent variable = ln(RATE)
Occupational groups

Independent variable	Managerial (OCC1)	Middle White (OCC2)	Junior White (OCC3)	Skilled Blue (OCC4)	Semi-skilled Blue (OCC5)	Unskilled (OCC6)
(ED4)						
ED0	—	−8.14 (.214)*	−.595 (.211)*	−.513 (.079)*	−.152 (.051)*	−.257 (.034)*
ED1	—	−.661 (.128)*	−.602 (.232)*	−.248 (.096)*	−.134 (.062)‡	−.224 (.040)*
ED2	−.209 (.154)	−.467 (.054)*	−.545 (.087)*	−.283 (.073)*	.089 (.046)	−.099 (.033)*
ED3	−.048 (.063)	−.215 (.034)*	−.205 (.040)*	−.085 (.067)	.082 (.043)	−.058 (.031)
ED5	.157 (.045)*	.191 (.032)*	.108 (.030)*	.055 (.185)	−.162 (.171)	−.380 (.323)
ED6	.572 (.030)*	.365 (.023)*	.333 (.029)*	1.080 (.589)	−.016 (.204)	—
EXP	.054 (.005)*	.044 (.003)*	.060 (.003)*	.013 (.007)‡	.013 (.004)*	.022 (.002)*
EXP^2 × 10^{-3}	−7.11 (.106)*	−.420 (.068)*	−.748 (.080)*	−.022 (.104)	−.069 (.064)	−.257 (.039)*
SEX	.139 (.034)*	−.030 (.021)	.041 (.017)‡	.063 (.098)	−.0133 (.039)	.057 (.019)*
ETHIOPIAN	−.784 (.323)‡	.301 (.282)	−.426 (.159)*	.163 (.604)	−.183 (.087)‡	−.065 (.072)
PUBLIC	−.314 (.045)*	−.087 (.032)*	−.035 (.030)	.092 (.052)	.250 (.029)*	.145 (.017)*
FOREIGN	.449 (.082)*	.712 (.086)*	.653 (.060)*	.965 (.147)*	.583 (.056)*	.533 (.058)*
Constant	1.012	.734	.433	.742	.481	.299
Adjusted R^2	.361	.379	.414	.236	.205	.169
F-statistic	80.43*	65.85*	101.21*	11.25*	27.27*	38.52*
Mean(lnRATE)	1.946	1.276	1.033	1.079	.958	.612
Sample Size	1407	1277	1703	400	1223	2027

* Significant at 1% level, two-tailed test
' Numbers in parentheses next to coefficient are standard errors.
‡ Significant at 5% level, two-tailed test
Source: Khartoum Employment Survey, 1989

tion flows have created manpower imbalances in the urban areas, especially in the three cities of Khartoum, Khartoum North, and Omdurman.

Although the analysis reveals high returns to college education, two intractable estimation problems leave open the question of whether the greatest gains in productivity are really attributable to more education. First, there remains the possibility of an unobserved correlation between unmeasured ability and school achievement which makes it difficult to determine if improvements in productivity are attributable to increased schooling or greater innate ability. There appear to be no grounds for assuming that unobserved ability bias is more serious in Sudan than in other African countries. If anything is missing from this analysis, it is more likely to be a measure of the quality of education received. Second, since a large proportion of successful college graduates enter the public sector, formal qualifications may merely serve as screening devices. Regrettably, without an adequate measure of ability any attempt to distinguish screening effects from productivity effects will be less

than perfect. Undoubtedly, however, the largest single employer, the public sector, screens workers for formal qualifications, and our data suggest that large private firms follow suit.

Finally, the temporal relationship between education and the labor market has been examined, an exercise motivated by Knight's (1979) theoretical work on occupational production functions, that follows a similar empirical strategy to that employed by Knight's labor collaborative work on East Africa. The analysis has uncovered important interactions between job characteristics and individual characteristics and identified how Sudan's rapid expansion of the education system has led to the filtering down of educational qualification and job competition, a process that should stimulate dynamic growth throughout the economy.

Although occupation could be a proxy for unmeasured ability, our data support Knight's (1979) original claim that accounting for workers' occupations aids our understanding of the way in which labor markets work in developing countries. The coefficient

on education in the basic Mincer specification is actually a reduced form coefficient that confounds two effects — the productivity enhancing impact of cognitive skills acquisition learned at school, and the probability of obtaining a particular job.

Perhaps some would argue that the more highly educated workers who end up in the low paying occupations are self-selected for unobserved characteristics, whereas workers with little education in these occupations are not; thus it is difficult to interpret either the returns to education or the effect of education on the earnings level within occupational groups. The suggestion from this analysis, however, is that equal recognition should be given to the fact that occupation is also strongly determined by exogenous factors such as the conditions of the labor market at the time of entry. Sudan's rapid expansion of secondary education has led to filtering-down and job competition, a process which is not to be discouraged as better educated workers are likely to be more productive and contribute to increased growth throughout the economy.[12]

It is important to remember that the above analysis is restricted solely to formal sector workers. Not captured in this analysis is the possibility that, increasingly, workers and especially educated workers, will not find any employment in the formal sector and be forced to find jobs in the informal/small-scale sector or operate their own small-scale enterprises. If the rate of return to education is lower in the informal sector than the formal sector, this may be a larger source of bias in our estimates of the rate of return to education than any suggested above. Clearly, what is called for is more research on the returns to various kinds of education and vocational training in Sudan's informal sector, and the interrelationship between the various parts of the informal and the formal sector. Only then can more explicit employment-promotion strategies and policies be formulated which are so urgently needed to absorb the burgeoning newcomers to the labor market resulting from the country's demographic situation.

Finally, despite the low rate of return to primary education, it seems fairly clear to us that Sudan needs to invest much more in basic primary-level education, since, aside from any direct gains made to raising formal sector output, the productivity-enhancing effects of a better educated work force in the dominant agricultural and informal sectors would be overwhelming. The contribution of improved educational attainments to raising the status of women, lowering fertility aspirations, improving maternal and child health and reducing infant and child mortality could be expected to be very significant.

NOTES

1. This was the special rate granted to the Operation Lifeline Project at its inception and was supposed to reflect prevailing black market conditions.

2. Perhaps the greatest area of potential bias in Khartoum centers on a potential correlation between schooling and informal labor networks (Cohen and House, 1993b).

3. The common theme among all of the above critiques is that the schooling coefficient may be biased in one direction or another. It is also worth noting, however, that none of these critiques questions whether schooling affects productivity, even though virtually no studies contain any direct measure of output. A completely different debate centers around this latter point. Some authors argue that formal education, per se, does little to increase productivity. Rather, most improvements are acquired through on-the-job training. Under this interpretation, the observed correlation between schooling and earnings reflects the fact that education is used by employers as a device for screening applicants for preexisting ability. Below, we first test the standard human capital model, then test for the importance of credentials.

4. Note that we must be particularly careful in interpreting a wage equation for women for whom labor force participation in market activities is irregular and, therefore, prone to self-selection biases (Heckman, 1980).

5. Psacharopoulos (1985) p. 588. The estimate is based on four countries: Ethiopia, Kenya, Morocco and Tanzania. Per

capita income was estimated for these countries at 120, 300, 590 and 250 US dollars respectively (World Bank, 1990). The comparable figure for Sudan was US$320.

6. An extreme version of this hypothesis is that formal education imparts nothing that augments workers' productivity; all improvements in productivity are learned after starting employment (i.e. on-the-job). Yet, even if this were the case, because employers have imperfect information regarding the productivity of potential workers, it is still rational for them to prefer educated workers over noneducated workers if academic advancement signals innate ability. This is because more able workers are easier and cheaper to train. At the same time, workers may attend school to obtain the necessary credentials to alert potential employers to preexisting differences in ability, rather than to acquire skills that would enhance their productivity.

7. As a necessary caveat, it proved difficult to identify respondents that failed any of their examinations. Compared to published data on examination pass rates, the respondents in the sample reported that they did considerably better than could be expected from a random sample. Hence, the simple correlation coefficients between particular years of education and specific qualifications is very high.

8. These results are available from the authors on request.

9. A human capital interpretation is that unmeasured ability is correlated with school achievement and more educated

(and therefore gifted), workers may develop greater skills once on-the-job. Alternatively, a "screening" interpretation would be that employers select workers with good credentials for jobs that require more instruction because they are likely to be more trainable.

10. We assume the worker is male, Sudanese, and has lived in Khartoum 23.18 years, which was the sample mean for this variable.

11. See, for example, Easterlin (1987) and Lee, Arthur and Rodgers (1988).

12. In comparing the postindependence education strategies of Kenya and Tanzania, Knight and Sabot (1990) conclude that Kenya's expansion of both primary and secondary education has led to positive economic grains as postprimary graduates have filtered down the occupation ladder, a process which has boosted productivity gains throughout the economy. Tanzania has experienced slower economic growth than Kenya as primary education expanded and the secondary sector stagnated. This lesson should not be lost on Sudanese planners; an optimal strategy calls for an expansion in both primary and secondary education.

REFERENCES

Becker, G. S., *Human Capital: A Theoretical and Empirical Analysis with Special Reference to Education*, 2nd Edition (Chicago: University of Chicago Press, 1975).

Cohen, B., and W. J. House, "Women's Urban Labour Market Status in Developing Countries: How Well do They Fare in Khartoum, Sudan?" *Journal of Development Studies*, Vol. 29, No. 3 (April 1993a), pp. 461–483.

Cohen, B., and W. J. House, "Informal networks, sector choice and labor earnings in Khartoum, Sudan," Mimeo (Washington D.C.: National Research Council, 1993b).

de Beyer, J., and J. B. Knight, "The role of occupation in the determination of wages," *Oxford Economic Papers*, Vol. 41, No. 3 (July 1989), pp. 595–618.

Easterlin, R. A., *Birth and Fortune: The Impact of Numbers on Personal Welfare*, 2nd Edition (Chicago: University of Chicago Press, 1987).

Fallon, P., "Labour markets in the Sudan," in O. S. Ertur and W. J. House (Eds.), *Population Studies and Human Resources Development in the Sudan* (Ames, IA: Iowa State University Press, 1994).

Heckman, J. J., "Sample selection bias as a specification error with an application to the estimation of labor supply functions," in J. P. Smith (Ed.), *Female Labor Supply: Theory and Estimation* (Princeton, NJ: Princeton University Press, 1980), pp. 206–248.

International Labor Office, *Employment and Economic Reform: Towards a Strategy for the Sudan* (Geneva: ILO, 1987).

Knight, J. B., "Job competition, occupational production functions and filtering down," *Oxford Economic Papers*, Vol. 31, No. 2 (July 1979), pp. 187–204.

Knight, J. B., and R. H. Sabot, *Education, Productivity and Inequality: The East African Natural Experiment* (Oxford: Oxford University Press, 1990).

Layard R., and G. Psacharopoulos, "The screening hypothesis and the returns to education," *Journal of Political Economy*, Vol. 82, No. 5 (October 1974), pp. 985–998.

Lee, R. D., W. B. Arthur and G. Rodgers (Eds.), *Economics of Changing Age Distributions in Developed Countries*, (Oxford: Clarendon Press, 1988).

Manski, C. F. and S. R. Lerman, "The estimation of choice probabilities from choice-based samples," *Econometrica*, Vol. 45, No. 8 (November 1977), pp. 1977–1988.

Mincer, J., *Schooling, Experience and Earnings* (New York: National Bureau of Economic Research, 1974).

Psacharopoulos, G., "Returns to education: A further international update and implications," *Journal of Human Resources*, Vol. 20, No. 4 (Fall 1985), pp. 538–597.

World Bank, *World Development Report 1990* (Washington DC: World Bank, 1990).

World Bank, *Sub-Saharan Africa: From Crisis to Sustain Growth: A Long-Term Perspective Study* (Washington DC: World Bank, 1989).

World Bank, *Education in Sub-Saharan Africa: Policies for Adjustment, Revitalization, and Expansion* (Washington DC: World Bank, 1988).

APPENDIX A. *Regression of extended earnings equation (total sample)**

Independent variable	Dependent variable = ln(RATE)		
	(1)	(2)	(3)
SCH	.058 (.006)[,]	.093 (.001)[,]	—
$SCH^2 \times 10^{-3}$	—	.013 (.392)	—
(ED4)			
ED0	—	—	-.736 (.094)[,]
ED1	—	—	-.549 (.131)[,]
ED2	—	—	-.300 (.128)[,]
ED3	—	—	-.128 (.093)
ED5	—	—	.076 (.034)[,]
ED6	—	—	.329 (.081)[,]
(ILLIT)			
PRIMARY	.055 (.028)[,]	.056 (.038)	-.095 (.089)
INTERMED	.132 (.049)[,]	.133 (.064)[,]	—
SECOND	.198 (.067)[,]	.199 (.079)[,]	.144 (.093)
DIPLOMA	.375 (.083)[,]	.376 (.091)[,]	.377 (.101)[,]
UNIVDEG	.463 (.090)[,]	.464 (.095)[,]	.326 (.124)[,]
POSTBAC	.577 (.103)[,]	.578 (.106)[,]	.511 (.129)[,]
MASTERPHD	.748 (.113)[,]	.748 (.113)[,]	.847 (.125)[,]
EXP	.055 (.001)[,]	.055 (.001)[,]	.054 (.001)[,]
$EXP^2 \times 10^3$	-.608 (.026)[,]	-.608 (.026)[,]	-.601 (.026)[,]
Constant	-.393	-.393	.367
Adjusted R^2	.594	.594	.593
F-statistic	1175.30[,]	1068.32[,]	838.11[,]
Sample Size	8037	8037	8037

* ln(RATE) = Natural logarithm of hourly earnings; ED0 = (1,0) No formal education; ED1 = (1,0) 1–3 years of school; ED2 = (1,0) 4–6 years of school; ED3 = (1,0) 7–9 years of school; ED4 = (1,0) 10–12 years of school; ED5 = (1,0) 13–16 years of school; ED6 = (1,0) more than sixteen years of school; ILLIT = (1,0) No qualifications; PRIMARY = (1,0) Primary leavers certificate; INTERMED = (1,0) Intermediate leavers certificate; SECOND = (1,0) Sudan schools certificate (Secondary); DIPLOMA = (1,0) Post-secondary school diploma; UNIVDEG = (1,0) Under-graduate degree; POSTBAC = (1,0) Post-Baccalaureate qualification; MASTERPHD = (1,0) Masters' degree/ Ph.D.; EXP = Years of Labor Market Experience
' Significant at the 1% level
' Figures in parentheses are standard errors
' Significant at the 5% level
Source: Khartoum Employment Survey, 1989

APPENDIX B. *Pairwise specification tests on occupation production functions**

	OCC1	OCC2	OCC3	OCC4	OCC5
(a) All Regressors:					
OCC2	60.08'	—	—	—	—
OCC3	47.79'	4.71'	—	—	—
OCC4	14.32'	2.82'	3.65'	—	—
OCC5	44.26'	18.04'	17.57'	6.65'	—
OCC6	75.73'	37.92'	33.27'	33.21'	35.94'
(b) Education:					
OCC2	15.99	—	—	—	—
OCC3	18.48'	2.20ᵗ	—	—	—
OCC4	.28	1.86	1.21	—	—
OCC5	4.84	12.23'	9.56'	6.56'	—
OCC6	5.70'	4.91'	5.39'	6.19'	4.75'
(c) Experience:					
OCC2	10.62'	—	—	—	—
OCC3	7.29'	.74	—	—	—
OCC4	21.68'	13.62'	19.03'	—	—
OCC5	69.16	58.93'	68.31'	4.48'	—
OCC6	96.72'	87.31'	107.4'	15.48'	3.84

* All statistics are F-distributed
' $p < .01$, two-tailed test
ᵗ $p < .05$, two-tailed test
Source: Khartoum Employment Survey, 1989