ON HUMAN CAPITAL IN POST-CONFLICT SUDAN: SOME EXPLORATORY RESULTS

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Abstract

The objective of this paper is to provide relevant information on various aspects of human capital inherited by the country as it entered its post-conflict phase of development. Such information is judged important for planning the future development of the country. Using established data sets the paper shows that the country's human capital stock, defined as average years of schooling of population aged 15 years and over, is very low (2.1-2.3 years per person in 2000), below the threshold of 4 years beyond which increasing returns to scale for human capital begin to accrue. It is also shown that the average rate of return to human capital is rather low (about 6 percent per year of schooling), contrary to established perceptions on such rates for developing countries. Rates of return to education are higher for higher levels of education, also contrary to established perceptions. Such patterns have implications for the inequality in the distribution of human capital over time. Moreover, it is shown that the country inherited a high degree of inequality in the distribution of education as measured by the education Gini coefficient which for 2000 was 0.725. These and other results suggest the importance of designing a relevant educational reform program for post-conflict Sudan.

حول رأس المال البشري في سودان ما بعد النزاع: بعض النتائج الاستكشافية

ملخص

يتمثل هدف هذه الورقة في توفير المعلومات المطلوبة حول مختلف جوانب رأس المال البشري الذي ورثه السودان وهو يدخل مرحلته التنموية ما بعد النزاع. ويعتقد بأهمية مثل هذه المعلومات لأغراض تخطيط مستقبل التنمية. وباستخدام قواعد المعلومات المتوفرة توضح الورقة أن رأس المال البشري، معرّفاً على أنه متوسط سنوات الدراسة للسكان من الفئة العمرية 15 سنة فما فوق، قد كان متدنياً للغاية عام 2000، وتراوح بين 2.1-2.3 سنة للفرد، وقل عن المستوى المرجح لرأس المال الذي تترتب عليه عوائد متزايدة للحجم وهو 4 سنوات للفرد. كذلك الحال أوضحت الورقة تدني متوسط معدل العائد على رأس المال البشري والذي قدّر بنحو 6 في المائة للسنة الدراسية، ونزوع معدل العائد على الارتفاع مع ارتفاع مستوى التعليم وذلك على عكس التوقعات حول سلوك هذا المعدل في الدول النامية، ولوحظ أن مثل هذا النمط لسلوك العائد على رأس المال البشري ينعكس على حالة المساواة في توزيع رأس المال البشري مع مرور الزمن. بالإضافة إلى ذلك، أوضحت الورقة أن القطر قد ورث درجة مرتفعة لعدم المساواة في توزيع التعليم كما يعكسها معامل جيني لتوزيع التعليم والذي قدّر بحوالي 0.725 لعام 2000. وتعني هذه النتائج أهمية صياغة برنامج ملائم للإصلاح التعليمي لسودان ما بعد النزاع.

I. Introduction:

In all likelihood post-conflict Sudan will be defined by the Comprehensive Peace Agreement (CPA) signed on the 9th of January 2005 by the Government of Sudan and the Sudan Peoples Liberation Movement/Army (SPLM/A). The CPA gave rise to the Interim National Constitution of the Republic of Sudan (INCRS) which will govern an interim period of six years and may become, after appropriate amendments, the permanent constitution of the country.

In post-conflict Sudan the overarching objective of development is seen as "the eradication of poverty, the attainment of the Millennium Development Goals, guaranteeing the equitable distribution of wealth, redressing imbalances of income and achieving a decent standard of life for all citizens" (article 10). Guiding principles, and directives pertaining to education, science art and culture are provided in article 13 of the INCRS such that the "State shall promote education at all levels all over the Sudan and shall ensure free and compulsory education at the primary level and in illiteracy eradication programs". These guiding principles and directives "are not by themselves enforceable in a court of law". However, under the Bill of Rights, article 44, the INCRS reaffirms that education "is a right for every citizen and the State shall provide access to education without discrimination as to religion, race, ethnicity, gender or disability. Primary education is compulsory and the State shall provide it free".

In chapter seven, devoted to the national civil service, the INCRS was also explicit about building capacity to manage the post-conflict development process. For this purpose a National Civil Service Commission is to be established to formulate "policies for training and recruitment into the national civil service, targeting between twenty to thirty percent of the positions for people of Southern Sudan who qualify" as per article 138[2].

In view of the above it is perhaps not surprising that the Joint Assessment Mission for Sudan (JAM (2005)) produced a two volumes report on 25 February 2005 entitled "Capacity Building and Institutional Development: Final Review Report: Volume I", and "Cluster Costings and Matrices: Final Review Report: Volume II". The JAM Sudan (2005-a: 20) report addressed the issue of priorities for capacity building in the country by noting that in order to "effectively implement the CPA, the capacity of the civil service to manage decentralized functions must be urgently addressed both in the South and the North. Its ability to plan and set priorities, manage revenue and expenditures, and deliver services efficiently and professionally must be strengthened. The role and functions of government and civil service policies as well as civil service pay scales and incentive structures should be reviewed and revised as necessary to raise the efficiency and professionalism of the civil service". The same is recommended for local authorities[3].

In the context of development in post-conflict Sudan, the references by the JAM report to capacity could be interpreted as relating to the existing human capital stock. Moreover, the frequent references to the pay scales of civil servants, and the incentive structures, could be interpreted as relating to returns to investment in human capital (i.e. returns to investment in education). We note in this respect that in estimating the resource requirements for the period 2005-2011 the JAM Sudan (2005-b: 9-13) report accorded basic, technical, vocational and adult education a very high priority. Without getting involved in details we note that the resource estimates are reported for two sub-periods, 2005-2007 and 2008-2011, and for three

levels of government: government of national unity, the three areas (Nuba Mountains, Blue Nile and Abyei), and the government of Southern Sudan[4].

For the government of national unity out of total resources of US$2.4 billion for the period 2005-2007 basic and related education is allocated about 25%, increasing to 31% out of US$4.9 billion estimated for the second period of 2008-2011. For the three areas basic and related education is allocated 28.9% of a total of US$680 million for the first period increasing to 33.8% of a total of US$1.1 billion for the second period. For the government of Southern Sudan the allocation for basic and related education is slightly lower at 10.7% of a total of about US$2.5 billion for the first period, increasing to 12.5% of a total of about US$4.2 billion for the second period. For the three levels of government, and for the whole period, basic and related education is allocated about 11.9% of a total envelope of resources of about US$6.7 billion. While JAM is to be commended on according basic education such a high priority, it is suspected that such allocations must have been informed by world patterns relating to returns on investment in education by level of education.

Having noted the above, the major objective of this paper is to address issues relating to what do we know about the stock of human capital, the rate of return to human capital, and the degree of inequality in the distribution of human capital as the country entered its post-conflict phase? Answers to such questions are judged crucial for planning the future development of the country. The stock of human capital, it is worthy of note, is defined on educational achievements as the average number of years of schooling in a population. The rate of return to investment in human capital (i.e. the rate of return to education) is the percentage increase in earnings as a result of one additional year of schooling.

The rest of the paper is organized as follows. Section (II) presents a very condensed summary of the most important methodological approaches for constructing human capital stocks and for estimating rates of return to human capital. Section (III) presents a number of benchmark results that will enable comparing Sudan with other countries. Section (IV) deals with estimates of human capital stock in Sudan, while section (V) reports rates of return to human capital in Sudan. Section (VI) concludes with a few remarks.

II. Preliminaries on Methodology:

2.1. Estimating Human Capital Stock: As noted in the introduction the stock of human capital is measured by the average years of schooling in a population. The most widely used estimates of human capital stock for various countries of the world are those due to Barro and Lee (2000, 1993)[5]. The estimation procedure used for deriving these estimates is the perpetual inventory method, where census, or survey, observations on attainment are used as benchmark stocks and new school entrants as flows are added to the stocks with an appropriate time lag. For developing countries the relevant estimates are for populations aged 15 years and over.

Barro and Lee (2000: 4-7) explain the method used to fill in the missing observations on school attainment by using information on school enrolment ratios and the structure of population by age groups. The formulae used to generate current flows of adult population, that are added to the benchmark stocks, for the various levels of schooling of the population aged 15 and over are given by the following:

(1) $H_{0,t} = H_{0,t-5}\,(1 - \delta_t) + L15_t*(1 - PRI_{t-5})$

(2) $H_{1,t} = H_{1,\,t-5}\,(1 - \delta_t) + L15_t*(PRI_{t-5} - SEC_t)$

(3) $H_{2,t} = H_{2,\,t-5}\,(1 - \delta_t) + L15_t*SEC_t - L20_t*HIGH_t$

(4) $H_{3,t} = H_{3,t-5}\,(1 - \delta_t) + L20_t*HIGH_t$

Where Hjt is the number of persons aged 15 and over for whom j is the highest level of school attained (j = 0 for no school, 1 for primary, 2 for secondary and 3 for higher). L15 is the number of persons aged 15-19 and L20 is the number of persons aged 20-24. The variables PRI, SEC and HIGH are the gross enrolment ratios (adjusted for repeaters) for primary, secondary and higher schools respectively. The variable δ is the mortality rate for persons aged 15 years and over. The mortality rate is estimated according to the following formula:

(5) $\delta_t = [L15_t + L_{t-5} - L_t]/\,L_{t-5}$

Where L_t is the total population aged 15 and over. In equations (1) – (4) it is assumed that the mortality rate is independent of the level of schooling, which is a problematic assumption to say the least. Substituting equation (5) into equations (1)-(4) one can easily get the school attainment ratio ($h_{jt} = H_{jt}/L_t$) for the four broad levels of schooling (no school, primary, secondary and higher)[6]. The three levels of regular schooling are then broken down into incomplete and complete education by using estimates of completion ratios .

Consistent with the above methodology Kyriacou (1992) used observations on human capital stock for 42 countries for the mid-1970s to estimate a relationship between the average years of schooling in the labor force, Ht, and lagged enrolment ratios for the three levels of education to be used for predicting future values for various countries. The estimated equation, with an R-squared value of 0.82, is given by the following, where figures between brackets are t-values):

(6) $h_t = 0.052 + 0.439*PRI_{t-15} + 2.665*SEC_{t-5} + 8.092*HIGH_{t-5}$

(4.48) (1.72) (2.62)

In Kyriacou t=1975 and the relationship was used to predict human capital for the years from 1965 to 1980 in five year intervals. In this respect it is noted that the assumption that the relationship between h and the lagged enrolment ratios remains constant over time and across countries implies that there are no differences among countries and over time in the length of each schooling level, the drop out ratios and the number of class repeaters. Despite the very strong nature of such assumptions it is found that human capital estimated by the above equation was very highly correlated with some of the estimates existing the literature with a a very high correlation coefficient of 0.85.

2.2. The Rate of Return to Human Capital: As is well known the estimation of the rate of return to education has been undertaken in the context of the human capital theory which was first developed by Mincer (1958) and subsequently extended by, among others, Becker (1964). In the context of this analysis the decision to educate oneself is seen as a rational one where the individual compares the costs and benefits of education. While there are various ways of presenting the basic ideas of this decision process the simplest one is to see it revolving around the comparison of two future streams of earnings discounted to the present by an appropriate discount rate. One stream corresponds to a lower level of schooling, with a constant flow of future income, say y_0, and another stream corresponding to a higher level of schooling, with a duration of S years, with a corresponding constant flow of future earnings, say y_s. At the decision point the individual is expected to be indifferent where the discounted present values of these streams of earning are equated (i.e. $V_0 = V_s$, where V is discounted present value)[7]. With a constant discount rate, say r, it can be shown that the equilibrium condition for the individual is given by:

$$(7) \quad y_s = y_0 e^{rs}$$

Taking logarithms of both sides the above equation can be written as:

$$(8) \quad \log y_s = \log y_0 + rS$$

where r is interpreted as the rate of return to an addition year of schooling. Thus, the earnings of an individual increase with investment in education. Without loss in generality, the earnings of the lower level of schooling, y_0 , can be taken as corresponding to those earned by non-educated workers. In the early development of this theory it was recognized that in addition to education, training on the job also enhances the earning capacity of individuals. Such training, it is observed, is associated with the worker's experience in the labor market. The contribution of experience to earnings, however, is expected to be subject to diminishing returns such that earnings peak at a given level of experience and decline thereafter. To capture these additional determinants equation (2) is augmented accordingly, where E denotes experience in the labor market, as follows:

$$(9) \quad \log y_s = \log y_0 + rS + \gamma E + \delta E^2$$

This now is the famous Mincer's earnings function that has been the work horse of estimation of the returns to investment in human capital where education is used as the embodiment of such capital. For applied work the above equation can be written as:

$$(10) \quad \log y_s = \alpha + \beta S + \gamma E + \delta E^2$$

Where α, β, γ, and δ are parameters to be estimated from relevant survey data[8].

The most important assumptions underlying the derivation of the Mincer's equation are: (a) the level of schooling does not affect the length of the working life of an individual; (b) the rate of discount, r, reflecting the cost of waiting for future income is the same for all individuals; (c) there is no risk aversion for the different individuals; (d) there is no rationing in the labor market for the more highly educated, in the sense that all individuals who manage

to get the level of education S are able to have an earnings stream corresponding to that level of education; and, (e) wages are determined competitively at all levels of education such that the higher pay for more educated labor is not due to administered pay policy by the government.

An extended version of Mincer's equation enables the estimation of the rates of return to investment in education for the various standard levels of education. The extended version takes the form:

(11) $\log y_s = \alpha + \Sigma\beta_k D_k + \gamma E + \delta E^2$

where D_k is a dummy variable for the k^{th} level of education (e.g. primary, secondary and tertiary). Under the extended equation the rate of return to the k^{th} level of education is obtained as:

(12) $r_k = [\beta_k - \beta_{k-1}]/ S_k$

where S_k is the number of years of schooling for the k^{th} level.

2.3. Measuring Inequality in the Distribution of Education: The theoretical justification for measuring inequality in the distribution of education has recently been made by, among others, Thomas, Wang and Fan (2000: 5). According to these authors if "an asset, say physical capital, is freely traded across firms in a competitive environment, its marginal will be equalized through free market mechanism. As a result, its contribution to output will not be affected by its distribution across firms and individuals. If an asset is not completely tradable, however, then the marginal product of the asset across individuals is not equalized, and there is an aggregation problem. In this case, aggregate production function depends not only on the average level of the asset but also on its distribution. Because education/skill is only partially tradable, the average level of education attainment alone is not sufficient to reflect the characteristics of a country's human capital".

Standard measures of inequality in the distribution of income, consumption expenditure and wealth can be used to measure the inequality in the distribution of education. The challenge for using such measures is the appropriate definition of the attribute of education over which the distribution is to be defined. The contribution of Thomas, Wang and Fan (2000) should be seen to lie in that dimension.

The most widely used measure of the degree of inequality in the distribution of income (or consumption expenditure) is the Gini coefficient. The Gini coefficient is based on the Lorenz curve[9]. The Lorenz curve is drawn on the basis of the cumulative percentage shares of the population (on the horizontal axis) against their corresponding cumulative percentage share of income (on the vertical axis), where population groups are arrayed from poorest to richest. If income is equally distributed such that everyone gets the mean income then the Lorenz curve coincides with the diagonal joining point zero on the horizontal axis to point 100 percent on the vertical axis. Otherwise, the curve traces points that lie below the diagonal. The ratio of the area between the diagonal and the Lorenz curve to the area of the unit triangle defines the Gini coefficient. Thomas, Wang and Fan (2000) propose using an education Gini defined on an education Lorenz curve.

For practical purposes, the Gini coefficient may be calculated on the basis of the following formula, where $L(y_i)$ is the cumulative education share of the i^{th} education group and p_i is the corresponding population density and where $L(y_0) = 0$ and where the summation goes from the first group to the last:

(13) $\quad Gini = 1 - \sum[L(y_i) + L(y_{i-1})]\, p_i$

Using Barro and Lee (2000) seven education groups (with subscripts of 1= illiterate; 2= partial primary; 3 = complete primary; 4= partial secondary; 5= complete secondary; 6= partial tertiary; and 7 = complete tertiary) Thomas, Wang and Fan (2000: 10) proposed the following formula for calculating the years of schooling, where C_j is the length of the j^{th} cycle of education (j = p, primary; s, secondary, t, tertiary):

(14) $y_1 = 0$; $y_2 = y_1 + 0.5Cp$; $y_3 = y_1 + C_p$; $y_4 = C_p + 0.5\, C_s$; $y_5 = C_p + C_s$; $y_6 = C_p + C_s + 0.5C_t$; $y_7 = C_p + C_s + C_t$.

On the basis of the above definition the cumulative proportion of schooling at each level is defined as follows, where μ is the average schooling years in the population:

(15) $L(y_1) = (p_1 y_1 / \mu) = 0$; $L(y_2) = [(p_1 y_1 + p_2 y_2)/ \mu]$; …$L(y_7) = (\Sigma p_i y_i)/ \mu = [\mu/ \mu] = 100\%$.

With these definitions an education Gini coefficient can be calculated based on Barro and Lee (2000) data sets.

III. Benchmark Results:

3.1. The Stock of Human Capital: Barro and Lee (2000: 29-30, table 4) report results on the trends of educational attainment in terms of average years of schooling for the population aged 15 years and over, for a number of country groups as well as for the world at large over the period 1960-2000. In table (1) we summarize these results for four relevant groups where we calculate the implied rates of growth of human capital over the period 1960-1995, even though we present the predicted level of human capital for 2000. The choice of the country groups is deliberate so that they can be used as comparators for Sudan.

Table (1): Trends in Human Capital: Average Years of Schooling for Population Aged 15 and Over for Selected Country Groupings

Country Group (number of countries)	1960	1995	2000	Annual Growth Rate (1960-1995; %)
Sub-Saharan Africa (22)	1.74	3.39	3.52	1.92
Middle East and North Africa (11)	1.23	4.98	5.44	4.08
All Developing Countries (73)	2.05	4.79	5.13	2.45
World (107)	4.64	6.44	6.66	0.92

The table shows that the predicted human capital stock for population aged 15 and over was about 6.7 years in 2000 at the level of the world. The three country groupings in the table have all achieved predicted levels of human capital below world average. On the other hand, over the period 1960-1985 the table also shows that in terms of human capital accumulation all three country groups have recorded actual annual rates of growth for human capital above

the world average growth rate of 0.92 percent. The highest rate of growth of human capital, of about 4.1 percent per annum, is recorded for the Middle East and North Africa region followed by that for the developing country grouping, with Sub-Saharan Africa recording an annual rate of growth of about 1.9 percent.

An emerging puzzle in the empirical literature is that despite the rather impressive expansion in the stock of human capital as measured by the average years of schooling in the population, GDP per capita did not show a similar trend. This is especially true in the developing regions of the world. Thus, the growth of educational capital per worker does not seem to have any association with the growth of output per worker[10].

The standard methodology of looking at the puzzle is the estimation of a production function relating output per worker, as a dependent variable, to physical capital per worker and human capital per worker as explanatory variables. The production function could be estimated in level form or as growth rates. The dominant functional form for the production function is the Cobb-Douglas function[11].

A recent careful study estimated a production function with variables expressed as rates of growth for a sample of 91 countries over the period 1960-1985 (Pritchett (1999-a)). The basic estimated equation (using ordinary least squares) shows an elasticity of output with respect to physical capital per worker of 0.524 that is significantly different from zero (with a t-value of 12.8). This is an expected result though slightly on the higher side compared to results obtained from national income accounts. On the other hand, the estimated equation shows an elasticity of output with respect to human capital per worker of –0.049 that is not significantly different from zero (with an absolute t-value of 1.07). At best, this implies that growth in per worker human capital has no effect on output. If the negative sign is taken into consideration, the result implies that there seems to be surplus human capital per worker. The coefficient of determination, which measures the goodness of fit of the relationship, is reported as 0.653, which is fairly high for estimations based on cross section observations. The result implies that about 65% of the variation in per worker GDP growth can be explained by variations in the two per worker capital inputs. This result is shown to be robust to measurement errors, a wide range of samples, data sets on GDP growth or human capital expansion and to estimation techniques[12].

3.2. Rates of Return to Human Capital: Over time rates of return to education, based on the Mincer's equation, have been reported to a large number of countries, developed as well as developing. Regular compilation of such results, with the objective of discerning world patterns, is also reported in the literature. The latest such compilations are provided in Psacharopoulos and Patrinos(2002), Banerjee and Duflo (2004), and the World Bank (2005). The compilation is based on the results using one of the three standard methods for the estimation of the rate of return to education. These methods are the “full method” of calculating the rate of return, the “basic Mincer” earnings function, and the “extended” earnings function[13]. The compilation is done for the latest year for which the results were reported. The results themselves are usually reported for the three main levels of education: primary, secondary and tertiary. The duration of each level of education may vary across countries.

According to the latest compilation by Psacharopoulos and Patrinos(2002: 14-15, tables 2-5) the most important world patterns could be summarized as follows:

(i) the rate of return to education declines with the level of development, as reflected by the level of per capita income, and the average years of schooling in the population. Low income countries (with an average per capita income of about US$755 or less, and average years of schooling of 7.6 years) recorded an average rate of return to education of about 10.9 percent. Middle income countries (with an average per capita income of more than US$755 but less than US$9265, and average years of schooling of 8.2 years) recorded an average rate of return to education of about 10.7 percent. High-income countries (with an average per capita income of US$9265 or more and average years of schooling of 9.4 years) recorded an average rate of return to education of 7.4 percent. Overall, the world average rate of return to education is 9.7 percent[14];

(ii) the rate of return to education is higher for the primary level (for the world at large such a rate is 26.6 percent) compared to that for the secondary (for the world: 17 percent) and tertiary (for the world: 19 percent) levels. Such pattern is found to hold for high income countries (with rates for the three levels of 25.6, 12.2, and 12.4 percent) and meddle income countries (27.4, 18 and 19.3 percent). For low income countries the pattern is a U-shaped one where the rate of return for the tertiary level is 26 percent higher than that for the primary level (25.8 percent) and that for the secondary level (19.9 percent);

(iii) the rate of return to the education of women is, on average, higher than that for the education of men, with an overall difference of about one percentage point (e.g. for the world the rates are 9.8 percent for women and 8.7 percent for men). This pattern , however, does not seem to hold for primary education (where the rate is 20.1 percent for men and 12.8 percent for women) and tertiary education (where the rate is 11 percent for men and 10.8 percent for women).

The above patterns, though not strongly supported by the evidence compiled from around the world, played an important role in the design of educational projects financed by the various donors, important among which is the World Bank, in the developing countries. The most influential recommendation for the design of such projects is that developing country governments should accord a higher priority for primary education and the education of girls. While such a recommendation can be supported from a developmental point of view, the differential rates of return to education by level or gender do not seem to provide a strong justification. At this stage, however, it is perhaps important to recall that the theoretical basis on which the Mincer equation is based may not be relevant to the development stage of a large number of developing countries.

In addition, the variability of the rate of return to education across countries, and by level of education, has been contested by Banerjee and Duflo (2005: 11-13). In their updated compilation these authors found that the mean rate of return is about 9 percent with a standard deviation of about 2.7 percentage points. The maximum rate of return of 15.4 percent is reported for Pakistan for 1991, and the minimum rate of 2.7 percent is reported for Italy for 1987. The authors regress the rates of return to education on the average educational attainment for a sample of 37 countries. A negative sign for the estimated coefficient, of 0.26, is reported and is found to be significant at the 10 percent level of significance. "The returns to education predicted from this regression range from 6.9% for the country with the highest

education level to 10.1% for the country with the lowest education level. This is a small range. There is therefore no *prima facie* evidence that returns to education are much higher when education is lower, although the relationship is indeed negative.

Moreover, from surveys for six Sub-Saharan African countries (Burkina Faso, Cote D'Ivoire, Ghana, Kenya, Nigeria and South Africa) Schultz (2004: ii95) concluded that in "contrast to the common description which states that returns are highest at primary school levels and decrease at secondary and post-secondary levels, these surveys imply private returns in six countries are highest at the secondary and post-secondary levels and generally as high for women as they are for men, though women are unlikely to enroll at these higher levels of schooling, with the exception of South Africa". The most important implication of such pattern of behavior of the rate of return to education is that inequality in education and earnings is likely to increase overtime both between families and within families.

3.3. Education Inequality: Thomas, Wang and Fan (2000), based on Barro and Lee (2000) data set, calculated the education Gini coefficient for 85 countries for population aged 15 years and over, for the period 1960 up to 1990. Their most important result is that inequality in the distribution of education, as measured by the education Gini coefficient, has been declining over time for most countries. Relatively rapid declines in education Gini coefficients are reported for Korea, Tunisia and China.

"Korea had the fastest expansion in education coverage and the fastest decline in education Gini coefficient; it dropped from 0.55 to 0.22 in 30 years": a decline at an annual rate of about 3 percent. Tunisia also recorded rapid improvement in the distribution of education where the education Gini coefficient declined from about 0.94 in 1960 to about 0.61 in 1990 at an annual rate of decline of 1.4 percent. A moderate rate of decline of the education Gini coefficient of about 0.45 per annum is reported for India (from 0.79 in 1960 to 0.69 in 1990).

Another result reported by the authors is that there is a negative relationship between the education Gini coefficient and the average years of schooling. This implies that countries with a higher education attainment level are most likely to achieve better education equality than those with lower attainment levels.

IV. Human Capital in Sudan:

Having noted the general results on the stock of human capital around the world, we are now in a position to look at the results for Sudan. The most recent estimates for human capital are provided in Barro and Lee (2000). The results for Sudan are reported in table (2).

Table (2): Sudan Educational Achievements of Population Over 15 Years: 1960-2000

Year	Population over age 15 years (millions)	%of Population with no Schooling	% of Population with First Level of Schooling	% of Population with Second Level of Schooling	% of Population with Post-Secondary Level of Schooling	Average Years of Schooling	Annual Rate of Growth of Human Capital (%)
1960	6.2	87.5	10.9	1.5	0.1	0.41	
1965	6.9	85.3	12.7	1.8	0.2	0.50	4.05
1970	7.7	82.7	14.4	2.6	0.3	0.62	4.40
1975	8.9	79.0	16.2	4.3	0.5	0.83	6.01
1980	10.3	74.3	19.0	6.0	0.7	1.14	6.55
1985	11.8	69.5	23.7	6.2	0.6	1.34	3.29
1990	13.6	65.9	24.7	8.4	0.9	1.64	4.12
1995	15.8	62.8	26.1	9.7	1.4	1.93	3.31
2000	18.3	60.0	27.4	10.7	1.9	2.14	2.09

Source: based on Barro and Lee (2000: appendix table A2).

The table shows the rather relatively modest educational achievements in Sudan since independence. In terms of human capital, the table shows that the average years of schooling for the relevant population category in Sudan was only 0.41 years in 1960 but increased to reach an estimated 2.14 years by 2000. For the year 2000 the educational achievement of Sudan was much lower than that of the world (an average of 6.7 years), that for the developing world (an average of 5.1 years), that for the Middle East and North Africa (with an average of 5.4 years) and that for Sub-Saharan Africa (an average of 3.5 years). At the level of details it is perhaps worth noting that for a sample of 27 Sub-Saharan African countries for which human capital stock for 2000 is reported in the Barro and Lee data set, Sudan's human capital stock was higher than that of Gambia (2.31 years), Guinea Bissau (0.84 years), Mali (0.88 years), Mozambique (1.11 years), and Niger (1.02 years). With such level of achievement the Sudan is still far below the 4 years threshold beyond which increasing returns to scale for human capital begin to accrue. When this threshold level of education is achieved, the quality of labor attains a critical mass allowing greater overall productivity[15].

Despite this very limited achievement the table shows that the stock of human capital per worker in Sudan has recorded rather impressive growth over the period. The annual growth rates of the stock of human capital ranged from a high of 6.55 percent for the period 1975-1980, to a low of 2.09 percent for the period 1995-2000. Up to 1980 the growth rate of human capital recorded an increasing pattern, but started to fluctuate thereafter on a declining trend from 6.6 percent in 1980 to 2.1 percent in 2000. For the whole period 1960-2000 the annual rate of growth of human capital is 4.28 percent.

Now looking at the fluctuating per capita growth record during the period since 1960, the experience of Sudan seems to conform to the emerging puzzle in the empirical growth literature noted earlier. The puzzle, it will be recalled, is that despite the rather impressive expansion in the stock of human capital as measured by the average years of schooling in the population, GDP per capita did not show a similar trend. This is especially true in the developing regions of the world including Sudan. Thus, the growth of educational capital per worker does not seem to have any association with the growth of output per worker.

Table (3) reports the results on per capita GDP growth rates in Sudan together with the results on human capital. The table confirms the ambiguity of the relationship between the increase in capital stock per worker and GDP per capita growth.

Table (3): Human Capital and Growth in Sudan 1960-2000

Period	Growth Rate of Human Capital per Worker (%)	Growth Rate of Per Capita GDP (%)	Output Elasticity with Respect to Human Capital
1960-1965	4.56	-1.25	-0.27
1965-1970	4.39	-0.61	-0.14
1970-1975	6.01	-1.85	-0.31
1975-1980	6.55	4.09	0.63
1980-1985	3.29	-0.34	-0.10
1985-1990	3.87	-0.45	-0.12
1990-1995	3.31	0.33	0.10
1995-2000	2.09	2.94	1.41

Source: based on table (2) and estimates of growth rates for half decades reported in Ali (2006).

The table shows that for the period 1960-1975 and the period 1980-1990 there was a negative relationship between the growth in the stock of human capital per worker and per capita GDP. A positive relationship between the two is recorded for the period 1975-1980 and for the 1990s decade. The absolute value of the elasticity of output with respect to human capital was less than unity for all the half decades except for the second half decade of the 1990s. Thus, on the whole no systematic relationship between the growth rate of human capital stock per worker and per capita GDP growth can be detected from Sudan's growth experience.

V. The Rate of Return to Human Capital in Sudan:

The data for estimating the rate of return to human capital in Sudan is obtained from the 1996 Migration and Labor Survey conducted by the Ministry of Labor. The survey was based on a multi-stage stratified cluster design for 16 States of Northern Sudan, where 3390 households were surveyed. The survey provided the usual information on household characteristics, the status of participation in the labor market, reasons for not working, out and return migration, housing conditions, wages, and number of months and hours worked.

After cleaning the data we ended up with 3052 observations: 2502 for males, and 550 for females. The results are reported in table (4), where figures between brackets are absolute t-values. As is obvious from the t-values all the estimated coefficients are significantly different from zero at the 1% level for the whole sample and for that of males. For the female sub-sample the coefficients for experience and its square are significantly different from zero at the 5% level of significance. The explanatory power of the regressions, as reflected by the adjusted R-squared, are wanting, but this is a standard feature of such regressions based on large cross-section data sets.

Table (4): Mincer's Equation for Sudan

Details	Sample	Males	Females
Years of Schooling	0.0611 (17.2)	0.0596 (15.0)	0.0629 (8.1)
Years of Experience	0.0365 (5.9)	0.0327 (4.9)	0.0369 (2.3)
Squared Years of Experience	-0.0004 (3.9)	-0.0003 (3.1)	-0.0006 (2.3)
Constant	6.8365 (72.6)	6.9673 (67.5)	6.6419 (29.4)
Adjusted R-squared	0.0913	0.0857	0.1286
Number of Observations	3052	2502	550

Source: own estimation.

Looking at the coefficient of the years of schooling the table shows that the rate of return to investment in human capital is about 6.1 percent for the Sudan as a whole, about 6 percent for males and 6.3 percent for females. These rates of return, we suggest, are rather low and do not support the world pattern. The difference in the rates of return between males and females is not very striking and amounts to about 0.3 percentage point much lower than that expected from world patterns. Such results of low rates of return to investment in human capital have been reported for a number of low income countries in Sub-Saharan Africa as well as in Arab countries[16].

We also estimated the extended Mincer equation for Sudan where we used dummies for four levels of education: literate, primary, secondary and tertiary with the illiterate category used as a reference category. The results are reported in table (5), where all the coefficients for the whole of the sample and that for males are significantly different from zero at the 1% level. For the female sample the coefficient on the illiterate dummy is not significant, that on the primary dummy is almost significantly different from zero at the 10% level (with a p-value of 0.104), those for experience and its square are significantly different from zero at the five percent level, while the rest are statistically different from zero at the 1% level.

Table (5): Extended Mincer's Equation for Sudan

Details	Sample	Males	Females
Literate Dummy	0.2749 (5.0)	0.2048 (3.5)	0.0657 (0.4)
Primary Dummy	0.5372 (8.7)	0.4626 (7.1)	0.34465 (1.6)
Secondary Dummy	0.5813 (11.7)	0.5403 (9.7)	0.5334 (4.9)
Tertiary Dummy	1.1824 (16.7)	1.1333 (14.0)	1.2254 (8.5)
Years of Experience	0.0332 (5.4)	0.0299 (4.4)	0.0354 (2.2)
Years of Experience Squared	-0.0003 (3.5)	-0.0003 (2.8)	-0.0006 (2.4)
Constant	6.8792 (72.3)	7.0289 (66.6)	6.7458 (29.8)
Adjusted R-squared	0.0969	0.0866	0.1403
Number of Observations	3052	2502	550

Source: own estimation.

Based on the above results and using 6 years for the length of both primary and secondary levels of education and four years for tertiary level we calculated the rates of return to education by level as in table (6) below.

Table (6): Rates of Return to Educational Levels in Sudan

Level of Education	Sample	Males	Females
Primary	4.37	4.20	4.68
Secondary	0.73	1.29	3.11
Tertiary	15.02	14.82	17.30

Contrary to world patterns the above table shows that the rates of return to primary and secondary education are very low, while that for higher education is rather high. For primary education the rate of return is about 4.4 percent for the country as a whole: 4.2 percent for males and 4.7 percent for females. For secondary education the rate of return is about 0.7 percent for the country as a whole: 1.3 percent for males and 3.1 for females. We hasten to note that this is a very problematic result in view of the fact that the rate of return for the country is supposed to be a weighted average of the two sub-samples. According to our calculations such a rate should have been 1.62 percent!! The rate of return to higher education is 15 percent for the country as a whole: 14.8 percent for males and 17.3 percent for females, with a margin of 2.5 percentage points in favor of educating females. Despite its non-conformity with world patterns the results exhibit the U-shaped pattern for the rate of return. The implication of the above results for resource allocation within the educational sector should be obvious.

VI. Education Inequality in Sudan:

The last set of results for Sudan is on education inequality. For this purpose we provide in the table below the relevant information for calculating the education Gini coefficient for the period 1960 to 2000. Recall that this information is provided for the percentage distribution of population aged 15 and over for the seven levels of education identified by Barro and Lee (2000).

Table (7): The Distribution of Population Aged 15 and Over by Highest Level of Education Attained

Year	No Schooling (p_1)	Incomplete Primary (p_2)	Complete Primary (p_3)	Incomplete Secondary (p_4)	Complete Secondary (p_5)	Incomplete Tertiary (p_6)	Complete Tertiary (p_7)
1960	0.875	0.085	0.024	0.012	0.003	0.001	00
1965	0.853	0.100	0.027	0.014	0.004	0.002	00
1970	0.827	0.114	0.030	0.021	0.005	0.002	0.001
1975	0.790	0.129	0.033	0.036	0.007	0.003	0.002
1980	0.743	0.153	0.039	0.046	0.014	0.004	0.003
1985	0.695	0.188	0.049	0.039	0.023	0.004	0.002
1990	0.659	0.196	0.051	0.066	0.018	0.005	0.004
1995	0.628	0.208	0.053	0.077	0.020	0.009	0.005
2000	0.600	0.218	0.056	0.085	0.022	0.012	0.007

Source: Barro and Lee (2000)

In what follows we report our calculations for the education Gini coefficient for the years 1960, 1990, 1995, and 2000. For 1960 the education cycle was 4 years of primary, 8 years of secondary (which was composed of 4 years intermediate and 4 years secondary) and 4 years tertiary. For the 1990s and beyond the education cycle used is 6 years primary, 6 years

secondary and 4 years tertiary. Recall that the incomplete level of education takes the value of half the duration of the complete cycle for all levels. Note also that the average years of education for the population group under consideration is calculated depending on the assumption on the duration of the cycle as $\Sigma p_i y_i$, and is not that reported in table (2) above based on Barro and Lee (2000). The results of our calculations are presented in table (8).

Table (8): Cumulative Proportion of Schooling and Education Gini Coefficient for Sudan for Selected Years

Level of Education/Details	1960	1990	1995	2000
Illiterate	0	0	0	0
Partial Primary	0.4126	0.3199	0.2999	0.2854
Complete Primary	0.6456	0.4778	0.4527	0.4306
Partial Secondary	0.8786	0.8010	0.7857	0.7634
Complete Secondary	0.9655	0.9185	0.9010	0.8782
Partial Tertiary	1.0000	0.9566	0.9615	0.9513
Complete Tertiary	-	1.0000	1.0000	1.0000
Average Years of Schooling	0.412	1.838	2.081	2.299
Annual Rate of Increase of Average Years of Schooling (%)	-	5.11	2.51	2.01
Education Gini Coefficient	0.913	0.764	0.742	0.725
Annual Rate of Change of Education Gini (%)	-	-0.59	-0.58	-0.46

Source: own calculations.

Consistent with world trends in inequality in the distribution of human capital, as summarized by educational attainment, the table shows that inequality in the distribution of human capital in Sudan declined from very high levels in 1960, with an education Gini coefficient of 0.913, to still fairly high level in 1995, with an education Gini of 0.742. The inequality in the distribution of human capital inherited by the country as it entered the post-conflict phase was also still fairly high with a Gini coefficient of 0.725.

In terms of the annual rates of decline in the education Gini the table shows that the period 1960-1990 recorded the highest rate of annual decline of 0.59 percent, which is a slow rate compared to world achievers like Korea (with an annual rate of decline of about 3 percent) and to those judged as having achieved moderate rates of decline like India (with an annual rate of decline of about 1 percent). The rates of annual decline of the education Gini in Sudan recorded a declining trend. The annual rate of decline of the education Gini inherited by the country as it entered the post-conflict phase is 0.46 percent. Note that this pattern in the annual rates of decline in the education Gini is consistent with the annual rates of growth of human capital stock: over the period 1960-1990 this rate was 5.1 percent, declined to 2.5 percent for the period 1990-1995 and further declined to 2 percent for the period 1995-2000.

VII. Summary and Policy Implications:

In this paper we looked at the human capital inherited by the country as it entered its pos-conflict phase. That human capital is vital for the development process in any country is very well established regularity. Two aspects of human capital are dealt with: the size of the stock and the rate of return.

The most important results pertaining to the size of the stock of human capital could be summarized as follows:

(i) Sudan entered its post-conflict phase with a very low stock of human capital estimated for the year 2000 as 2.14 years per person of 15 years of age and over. This is a stock of human capital that is lower than the average for Sub-Saharan Africa (of 3.52 years), for the Middle East and North Africa region (of 5.44 years), for the developing countries (5.13 years), and for the world (6.66 years);

(ii) over the period 1960-1995 human capital stock increased at annual rates that fluctuated widely with a high rate of 6.55 percent for the period 1975-1980 and a low rate of 2.09 percent for the period 1995-2000. Over the period 1960-2000 the annual rate of increase of human capital stock was 4.22 percent;

(iii) the increase in the human capital stock of the country was not systematically related to the growth rate of per capita GDP

The most important results relating to the rate of return to human capital, as estimated for 1996, could be summarized as follows:

(a) that the rate of return to human capital, estimated as about 6 percent for an additional year of schooling, is rather low contradicting world patterns which expect such a rate to be higher for low-income countries. It can, however, be said to be reasonable compared to an overall world average of about 10 percent;

(b) that there does not seem to be a noticeable difference in the rate of return to human capital of males and females; once again contradicting world patterns; and,

(c) that the rate of return to higher education is much higher than that for secondary and primary, and that for primary is higher than that for secondary. Such pattern, though mirrors world patterns, contradicts the most widely perceived pattern of primary education having the highest rate among all levels of education.

The most important results pertaining to the inequality in the distribution of human capital in the country as measured by the education Gini coefficient could be summarized in the observation that the country started off with a very high degree of inequality in 1960 (with a Gini coefficient of about 0.913), and like most countries in the world such inequality recorded a declining trend. However, the rate of decline of the education Gini was very low (less than one percent per annum) resulting in the country inheriting a fairly high degree of inequality in the distribution of its human capital (with a Gini coefficient of 0.725)

A number of policy implications can be drawn from the above results. Given the methodology of estimating the stock of human capital it is perhaps obvious to suggest that conducting a population census should be given a very high priority and that as much detailed information on the education status of the population should be generated from such census even at the extent of introducing a non-conventional module in the standard census instrument. Following the conduct of the census more up-to-date estimates of the stock of human capital can be established on the basis of which capacity building needs could be assessed, especially in Southern Sudan.

The pattern of the rates of return to human capital by level of education reported in this paper needs to be confirmed. The 1996 Migration and Labor Force Survey on which the results are based is not a high quality data set in view of the fact that it was conducted in Northern Sudan to the exclusion of the South. If confirmed, then the results should be used to inform

the design of an appropriate educational reform program that takes into account the social justice implications of high rates of return to higher education. In the long-run such pattern of rates of return may result in increased inequality (see, for example, Schultz (2004)). In view of the fact that the INCRS is committed to social justice as well as to balanced regional development, educational reform becomes an imperative in post-conflict Sudan with a view of improving the distribution of education. This implication is also confirmed by the results of the calculation of the education Gini coefficient.

From a planning point of view, and adopting the MDG methodology of specifying quantitative targets over a specified time horizon, the above results could be used to answer questions such as how long would it take the country to reach the benchmark level of human capital of 4 years per person of 15 years and over? Thus, for example, given the information in table (8) it can easily be shown that it will take the country about 40 years to reach such a target (starting from an initial value of 2.299 years) if the annual growth rate of its human capital is assumed to be 4.4 percent, the rate for the whole period 1960-2000. Alternatively, if the country is to achieve such a target within a 20 year planning horizon its human capital stock needs to grow by an annual rate of 9.1 percent. Both alternatives have obvious implications for spending on education.

Footnotes

[1] Paper prepared for presentation at the Sudan Research Group third workshop.

[2] For the details of the economic and development content of the CPA and the INCRS see Ali (2006).

[3] See also JAM Sudan (2005-a: 17).

[4] Costing estimates are done for eight clusters: institutional reform and capacity building; governance; economic policy and management; productive activities; basic services; infrastructure; livelihoods and social protection; and information. Basic, and related, education is covered under "basic services".

[5] For other data sets see, for example, Psacharopoulos and Arriagada (1986) and Nehru, Swanson and Dubey (1995).

[6] Data for enrolment ratios is usually available from UNESCO, while data on the structure of population by age, and their projections, is available from the United Nations.

[7] Note that $V_0 = y_0 \int e^{-rt} dt$, where the limits of integration go from zero to n, the length of the working life of the individual; and $V_s = y_s \int e^{-rt} dt$ where the limits of integration go from S to S+n. Upon performing the integration we get equation (1) in the text.

[8] The semi-logarithmic structure of Mincer's earnings equation can be obtained from the utility maximization framework of Becker (1964). Card (1995, 1998) gives a simplified utility framework as follows where U is the utility function $U(y(S), S) = \log y(S) - h(S)$, where the income of the individual is assumed a function of the years of education. The function h(S) is supposed to reflect the cost of education with positive first and second partials(i.e. $h'(S) > 0$; $h''(S) > 0$). The individual maximizes utility by choice of S, the level of schooling and the first order condition is $[dy/dS][1/y] = dh/dS$; that is the marginal cost of an additional year of schooling is equated to the return to the year of schooling as given by the ratio of the marginal productivity of the year of schooling to the income for that level of schooling. By an appropriate choice for the functions y and h it can be shown that a semi-logarithmic earnings equation can be obtained as a function of the level of schooling, S, and its square.

[9] Other measures of inequality are to be found in, among others, Sen (1997), Kakwani (1980), and Anand (1977). The statistical measures of inequality include the following the range; the relative mean deviation; the variance; the coefficient of variation; and the standard deviation of the logarithms of income. The most famous welfare based measure of inequality is Atkinson's measure which relies on the idea of the equally distributed equivalent income, y_e, defined as that level of per capita income which if enjoyed by everybody would make total welfare exactly equal to the total welfare generated by the actual distribution of income. Another famous measure of inequality is Theil's measure based on the idea of entropy.

[10] Barro (1997) reports that initial human capital as measured by the years of schooling at the secondary and higher levels for males aged twenty-five and over is a significant and positive determinant of subsequent economic growth. Moreover, he also shows that male primary education and female education at all levels are not significant in explaining long run growth.

[11] It will be recalled that a generally specified production function usually takes the following form: Y =F(K, L, H) where Y is output, K is physical capital stock, L labor, and H is human capital stock. If the production technology exhibits constant returns to scale then output per worker, y=Y/L can be expressed as y= f(k, h) where k is physical capital per worker and h is human capital per worker. A per worker Cobb-Douglas function takes the form $y = A\, k^{\alpha} h^{\beta}$, where A is a technology parameter and α andβ are output elasticities with respect to physical and human capital respectively.

[12] See Benhabib and Spiegel (1994) and Thomas et al (2000) for attempts to salvage a positive and significant relationship between human capital input and output . The attempt by Thomas et al (2000) is based on using lagged output increments in PPP rather than growth rates and incorporating an education Gini coefficient in the production function.

[13] According to Psacharopoulos (1994:1325) the "full method requires working with detailed age-earnings profiles by level of education and finding the discount rate that equates a stream of education benefits to a stream of education costs at a given point in time. The basic earnings function involves the fitting of a semi-log ordinary least squares regression using the natural logarithm of earnings as the dependent variable, and years of schooling and potential years of labor market experience and its square as independent variables". The extended earnings function converts the continuous years of schooling into a series of dummy variables referring to the completion of the main schooling cycles: primary, secondary and tertiary.`

[14] Note the average per capita income is reported as US$375 for low, US$3025 for medium, and US$23465 for high, income countries.

[15] See World Bank (1998: 10) and the references cited there. Note, however, that the World Bank (2005: 285: table A4) reports that for 2000 the mean years of schooling for Sudan is 4.01. This record is confusing in view of the fact that the World Bank draws on Barro and Lee data base from which our table is drawn. But also note that in the table the 2000 result was a projection and the World Bank (2005) result may have been an actual calculation. These results are very sensitive to the assumed length of the "incomplete" education cycle. Our own calculations, using Barro and Lee details of the distribution of population over educational levels gives rise to average years of schooling which are slightly different from those of Barro and Lee.

[16] Our results are not different from those reported by Suliman (2005: 13, table 3) for Khartoum State using the same 1996 labor survey !! According to Suliman the rate of return to education in Khartoum is about 7 percent: 7.2 percent for males, and 6.6 percent for females. The results for a survey which he conducted in 2005, based on the sampling frame of the 1996 survey, produced rates of return of 7.7 percent overall: 7.7 percent for males and 7.6 for females. For a pooled sample (combining 1996 and 2005 observations) the rates of return are reported as 6.1 percent overall: 6 percent for males, and 6.2 percent for females. Note that the result reported for Sudan in Psacharopoulos and Patrinos (2002: 20, table A2) of a rate of return of 9.3 percent (and an average years of schooling of 10.2) is clearly misleading. The source of the result is Cohen and House (1994), who like Suliman, were dealing with Khartoum State!! The same misleading result for Sudan is reported in Banaerjee and Duflo (2005: appendix table 1)!!!

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