

## **Abstract**

This paper investigates whether the growth effects of human capital in African countries differ from the growth effects of human capital in the world as a whole. Using an endogenous growth model, panel data, and both cross-sectional regression and a dynamic panel estimator, we find that the effect of human capital on the growth rate of GDP in Africa does not differ significantly from the growth impact of human capital in the world as a whole. Our results suggest that Africa does not grow any differently from the rest of the world. The observed growth differential between Africa and the rest of the world can be attributed to the fact that Africa has low endowments of growth-enhancing characteristics. Our results have interesting growth policy implications.

**KEY WORDS: HUMAN CAPITAL, ENDOGENOUS GROWTH, DIFFERENCE, AFRICA, PANEL DATA, DPD ESTIMATOR**

**JEL CLASSIFICATION: O4, O5, O1, I1**

# Human Capital and Economic Growth: Is Africa Different?<sup>1</sup>

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# 1 Introduction

Economic performance in the African region has been abysmal, at best. In 1999, per capita GDP in Sub-Saharan Africa was only 42% of the average for the developing world and 22% of the world average.<sup>1</sup> Sub-Saharan Africa's Human Development Index (HDI) in 1998 was .46, only 72% and 65% of the developing world's and total world's averages of .642 and .712 respectively.<sup>2</sup> Indeed, Africa is the only region in the developing world where the per capita income declined during the 1991-2000 period. What is interesting is that Africa does not only have low living standards but these low living standards are decreasing in absolute terms despite efforts at structural reforms championed by multilateral development agencies, such as the World Bank and the International Monetary Fund. Indeed during the 1998-1999 period, per capita income in African countries declined at the rate of .3%, compared to the world and low-income countries per capita income average growth rates of 1.3% and 2.5% respectively.<sup>3</sup>

This poor economic performance has led some researchers to suggest that the structure of economic growth in Africa is "different" from that of other parts of the world. Several researchers have tested this "African difference" by including an Africa dummy variable in the growth equations they estimate. Invariably, they find the African dummy to be negative and statistically significant in the growth equation (Sachs and Warner: 1997, Block: 2001, Bloom and Sachs: 1998 Easterly and Levine: 1997, among others). Why might the growth process in Africa be different?. Some researchers have suggested that geography may explain most of the African effect in growth regressions (Sachs and Warner: 1997, Bloom and Sachs: 1998). Africa is mostly tropical with its poor soils incapable of supporting sustained and productive agriculture, and her harsh environment supports many endemic and productivity crippling diseases such as malaria and sleeping sickness. Indeed Gallup and Sachs (2000) calculate that a 10% reduction in the incidence of malaria alone will increase the growth rate of per capita income in malaria infested areas by .3 percentage points. Other researchers argue that Africa's growth tragedy can be attributed to political instability and institutional weaknesses (Collier and Gunning: 1999, Londregan and Poole: 1990, Block: 2001, and Temple: 1998, among others). Finally, other researchers argue that the African difference can be explained by colonialism since African countries have not had to adjust from colonial experience (Price: 2001).

If Africa grows differently from other regions of the world, then researchers and policy makers

should focus on developing and implementing a different growth model for Africa rather than trying to implement a general growth model for Africa as evidenced by the works of international and bilateral development agencies. It is possible that the growth structure of African countries does not differ from those of other parts of the world but Africa's growth rate differs because she has a lower endowment of growth characteristics and those characteristics may be less productive in Africa than elsewhere. In particular, Africa's human and physical capital stocks as well as institutions may be below the minimal threshold necessary for sustained growth. If that is the case, then policy should focus on how to increase the endowment and "productivity" of Africa's growth characteristics rather than treating Africa as different.

This paper investigates one aspect of the "African difference": it uses panel data and a dynamic panel estimator to investigate whether growth impact of human capital in African countries differs from the growth impact of human capital in other parts of the world. We do so by estimating an endogenous growth equation with both African and world data and testing to see if the two sets of estimates are the same. We define and measure human capital broadly to include both education and health in this study. This approach is different from previous studies of the impact of human capital on growth that have focused exclusively either on education or health since we include the two aspects of human capital in one study. The use of the dynamic panel estimator also allows us to account for the possible endogeneity of regressors in order to obtain consistent estimates. To our knowledge, this is the only study that uses two dimensions of human capital to investigate the sources of the differential growth rate of income in Africa as compared to other parts of the world.

We find that the growth impact of both education and health human capital in Africa is similar to the growth impacts of these variables in the world as a whole. Our results are robust with respect to estimation methodology and the measure of human capital we use. Perhaps, African countries grow slower than the rest of the world because their endowments of growth-enhancing characteristics are much lower than the averages for the world. Our results are consistent with the results obtained by earlier researchers who find that the structure of growth in Africa is not different from that of the rest of the world and that Africa should be treated as any other region of the world. However, they are inconsistent with those of researchers who find that Africa grows differently from the rest of the world and should therefore be treated as a special case. Our results indicate that Africa is not a special case and that it should do what other parts of the world have done to achieve fast economic growth—adopt and effectively implement appropriate growth

enhancing policies.

The rest of the paper is organized as follows: Section 2 briefly presents an endogenous growth model that includes both education and health human in addition to physical capital as regressors. We describe the data and the estimating strategy in section 3. Section 4 presents and discusses the statistical results while section 5 concludes the paper.

## 2 Model

We use an endogenous growth model to investigate the differential impact of the stock of human capital on economic growth in Africa as compared to the growth impact of human capital in other parts of the world. Following the endogenous growth literature, (Barro: 1991, Caselli *et al*: 1996, Romer: 1990, Jones: 1997, Aghion and Howitt : 1998, Benhabib and Spiegel: 1994, van Zorn and Muysken: 2001 among others), we make aggregate output a function of technology ( $A$ ), labor ( $L$ ), the stocks of physical capital, health and education human capital ( $K, H, E$ ), and environment factors ( $\mathbf{Z}$ ). While human capital has been broadly defined in the theoretical growth literature, empirical growth models have mostly focused on education as the measure of human capital. Recent research has begun to focus on the effect of health on the growth rate of income (Shultz: 1999, Over: 1992, Bhargava *et al*: 2001, Gallup and Sachs: 2000, Sachs and Warner: 1997, Knowles and Owen: 1995, 1997, Weil: 2001, Mayer: 2001). To provide a broader measurement of human capital, we include both the education and health components of human capital in our study. The aggregate production function we postulates given as:

$$Y = Y(A, K, H, E, L, \mathbf{Z}) \tag{1}$$

where all variables are as defined in th text above.

The production function can be written in per capita terms as:  $y = y(a, k, h, e, \mathbf{Z})$ , where lower case variables are per capita equivalent of their upper case counterparts. The growth rate of per capita output ( $\dot{y}$ ) is a function of the growth rate of the arguments of the per capita output equation. We assume that a constant proportion of output is devoted to the the formation of both physical and human capital (the savings rate). Following the endogenous growth literature, we also assume that the rate of accumulation and the productivity of additional human capital depends on the *stocks* of human capital. As in the endogenous growth literature, we also make the growth rate of technology a function of the stocks of human capital and policy variables in  $\mathbf{Z}$ . This makes the

growth rate of per capita income a function of the savings rate, the stocks of human capital, and the vector of environmental variables. We write the per capita income growth equation as:

$$\dot{y} = \dot{y}(s, h, e, \mathbf{Z}) \quad (2)$$

where  $s$  is the savings rate and all other variables are as defined above. The growth rate of per capita income equation has  $\mathbf{Z}$ , an aggregate variable, an argument rather than the per capita environmental variables. This reflects our assumption that because of externalities, it is the aggregate environmental variables that determine the growth rate of per capita income.

To estimate (2), we have to define the explanatory variables and provide a specific functional form for the growth equation. We follow earlier researchers and proxy the savings rate by the investment/GDP ratio ( $k$ ). We represent the stock of health human capital with life expectancy at birth ( $life$ ) and the average daily caloric intake in a country ( $calorie$ ), while we proxy education human capital ( $edu$ ) by the educational attainment of the working age population. The  $\mathbf{Z}$  vector includes variables that previous research has shown to influence the growth rate of income. We include  $y_0$  as an explanatory variable to test the convergence hypothesis. Convergence would imply a negative coefficient on  $y_0$ . Edwards (1998) and Feder (1983) argue that export growth has a positive effect on the growth rate of per capita income in a country because of the efficiency of the export sector. We follow these researchers and include the growth rate of exports ( $\dot{x}$ ) as an additional regressor.

The growth equation we have developed is for the growth rate of per capita income. However, the data we use to estimate the growth rate equation is for aggregate GDP ( $g$ ) rather than the growth rate of per capita income ( $\dot{y}$ ). To properly reflect the use of the growth rate of aggregate GDP as our regressor, we add the growth rate of the labor force, which we proxy by the growth rate of population an additional regressor. The growth rate equation we estimate is:

$$g = \alpha_0 + \alpha_1 life + \alpha_2 k + \alpha_3 calorie + \alpha_4 popgro + \alpha_5 edu + \alpha_6 y_0 + \alpha_7 \dot{x} + \xi \quad (3)$$

where  $g$  is the growth rate of aggregate real GDP,  $\xi$  is a stochastic error term and all other variables are as defined above.<sup>4</sup> We expect the coefficients of  $k$ ,  $life$ ,  $calorie$ ,  $edu$  and  $\dot{x}$  to be positive in the growth equation. If population growth leads to a reduction in the growth rate of *per capita income* as growth theory indicates, then we expect the coefficient of  $popgro$  to be positive, but significantly less than unity.

### 3 Estimation Method and Data

#### 3.1 Estimation Method: The Dynamic Panel Estimator

We estimate the income growth rate equation with panel data from 131 countries, 47 of which are African countries, over the 1960 to 1998 period. The equation contains country fixed effects which are correlated with the regressors, hence orthogonality between the error term and the regressors is not likely to be met for either the Generalized Least Squares (GLS) or the Fixed Effects (FE) estimator to produce consistent estimates. One can achieve orthogonality through appropriate differencing of the data. However, the equation contains endogenous regressors as well as the effects of lagged endogenous variables, implying that the error term in the differenced equation is correlated with the lagged dependent variable through contemporaneous error terms in period  $t - j$ . Therefore, neither the FE nor the GLS estimator will produce consistent estimates under these circumstances. An instrumental variable (IV) estimator that can correct for correlated fixed effects as well as account for endogeneity of regressors is required.

Arellano and Bond (1991) have proposed a dynamic panel data estimator (DPD) based on General Method of Moments (GMM) methodology that optimally exploits the linear moment restrictions implied by the dynamic panel growth model we have proposed. The dynamic GMM estimator is an IV estimator that uses lagged values of all endogenous regressors as well as lagged and current values of all strictly exogenous regressors as instruments. The estimator requires that the variables be measured as deviations from their period means. The dynamic GMM estimator is given as:

$$\hat{\theta} = (\bar{\mathbf{X}}' \mathbf{Z} \mathbf{A}_N \mathbf{Z}' \bar{\mathbf{X}})^{-1} \bar{\mathbf{X}}' \mathbf{Z} \mathbf{A}_N \mathbf{Z}' \bar{\mathbf{y}} \quad (4)$$

where  $\hat{\theta}$  is the vector of coefficient estimates on both the endogenous and exogenous regressors,  $\bar{\mathbf{X}}$  and  $\bar{\mathbf{y}}$  are the vectors of first differences of all the explanatory variables,  $\mathbf{Z}$  is the vector of instruments and  $\mathbf{A}_N$  is a vector used to weight the instruments. This IV estimator is equivalent to an efficient Three Stage Least Squares (3SLS) estimator.

Arellano and Bond proposed two estimators—one-step and two-step estimators—with the two step estimator being the optimal estimator. The difference between the two estimators is the weighting matrix used to obtain the estimates. The one-step estimator is obtained when the weighting matrix is the average covariance matrix of  $Z\bar{v}_i$  given by  $A_N = (N^{-1} \sum_i Z_i' H Z_i)^{-1}$  where  $H$  is a  $T - 2$  square matrix with 2s in the main diagonal, -1s in the first sub-diagonal, and 0s

everywhere else. The optimal two step estimator replaces the  $H$  matrix with an estimated variance-covariance matrix formed from the residuals of a preliminary consistent estimate of  $\theta$ . The optimal choice of  $A_N$  for the two step estimator is given as:  $A_N = \hat{V}_N = N^{-1} \sum_i Z_i' \hat{v}_i \hat{v}_i Z_i$  where  $\hat{v}_i$  are the residuals obtained from a preliminary consistent estimate of  $\theta$ . The two estimators will be asymptotically equivalent if the error terms are spherical. We use Arellano and Bond's two-step estimator to estimate the model.

In estimating the model, we lagged all explanatory variables by one period to ensure that  $y_{t-1}$  can be treated as predetermined in period  $t$  and that the error terms would not be serially correlated. We make two identifying assumptions. First, we assume that there is no first or second order serial correlation among the error terms. Second, endogenous regressors are not considered predetermined for  $v_{i,t}$  but are considered so for  $v_{i,t+2}$ . This allows us to use all  $x_t$  up to  $x_{t-1}$  as valid instruments for  $\hat{x}_t$ . The linear moment restriction implied by our model is  $E[(\Delta \tilde{y}_{it} - \Delta \tilde{X}'_{i,t-1} \Theta) X_{i,t-j}] = 0$  for  $j = 2, \dots, t-1$ , where  $X' = (y_{t-1}, X)$  is the vector of lagged endogenous and strictly exogenous regressors. The consistency of the estimates hinges on the assumption of lack of autocorrelation of the error terms so we test for the existence of first and second order serial correlation. We also perform Sargan's test, which is a joint test of model specification and the appropriateness of the instrument vector. If all regressors are strictly exogenous, the DPD estimator is consistent but not efficient compared to the FE estimator. On the other hand, if there are endogenous regressors, the DPD estimator is consistent while the other estimators are inconsistent. We therefore use a Hausman test (1978) to test for the strict exogeneity of all regressors.

### 3.2 Data

The endogenous variable in the model is the growth rate of aggregate real GDP ( $g$ ) which we measure as the annual growth rate of real GDP in a country. The explanatory variables in the model are the investment rate ( $k$ ), health human capital, education human capital, the growth rate of real exports ( $\dot{x}$ ), initial per capita income ( $y_0$ ), and the growth rate of the labor force. We follow the standard approach and measure  $k$  as the gross domestic fixed investment/GDP ratio while we measure  $y_0$  as the real per capita GDP of a country in 1987 PPP US\$ at the beginning of a period. We measure  $\dot{x}$  as the annual growth rate of real export earnings in a country while we use the growth rate of population (*popgro*) to proxy the growth rate of the labor force.<sup>5</sup> We measure *edu* as the average years of educational attainment of the working age population (i.e. those aged 25

years and above) in a country in a year. We choose to use education of the working age population rather than enrolment ratios because of the long lag between enrolment and employment.

Health human capital has been measured in different ways by different researchers. Some researchers measure it as life expectancy at birth, others have measured it as infant mortality rates; still others measure it as the inverse of mortality rates (Shultz: 1999). Average height has been used other researchers (Weil: 2001) to measure the stock of health human capital in empirical research. None of these measures is an ideal measure since one would like to have a measure of health capital that measures not only the absence of illness but also the amount of effort exerted at work. We proxy health human capital in this study by two variables—life expectancy at birth (*life*) and average daily caloric intake (*calorie*). The former reflects the stock of health human capital while the latter reflects additions to the stock of health human capital over the period under considerations. Caloric intake may also be a measure of effort resulting from good health. Other variables used as instruments in the dynamic panel estimates are the proportions of the population that is less than 15 years old (*s14*) or greater than 65 years old (*s65*).

Data for estimating the model were obtained from a variety of sources. Data for the for  $g$ ,  $\dot{x}$ , *life*,  $k$ , and *popgro* were obtained from the World Bank’s *World Development Indicators, 2000*, (Washington, D.C.: World Bank, 2000). Data for  $y_0$  were obtained from the *World Development Indicators, 2000*, and Summers and Heston’s *Penn World Tables*, Mach 5.6. The data for *edu* were obtained from Barro and Lee (2000) while the *calorie* data were obtained from the *United Nations Statistical Yearbook*, various years. The data are annual observations for 131 countries, 47 of which are African countries, from 1960 to 1998. To reduce the effects of business cycles on our results, we took five year averages of the variables, as is usually done in the empirical growth studies. Not all countries had valid observations for all years so we had a total of 852 (311) observations for the total (African) sample. The *edu* data did not have information for several countries in our sample, and merging that data set with the other data sets reduced our sample size. We therefore created two sample sets—with and without *edu*. The total sample with *edu* had a total of 692 while the African data set that includes *edu* has 205 observations. We present estimates based on each of the samples.

Summary statistics of the sample data are presented in Table I. Average income, the stock of health and education human capital, caloric intake, export growth rate, as well as the proportion of GDP devoted to investment in physical capital are much higher in the entire sample compared

to the values of these variables in Africa. Per capita income in African countries is only about 20% of that the average for the entire sample. On the other hand average population growth rate is much higher in African countries than in the entire sample. The average growth rate of GDP in African countries is lower than the average growth rate in the world. The combined effect of slower GDP growth and higher population growth rate implies that per capita income will grow at a slower pace in Africa compared to the rest of the world. The data is consistent with the idea that larger stocks of, and faster accumulation of, human capital is positively correlated with the level of, and growth rate of, income. It is also interesting to note that the variance in the health and education human capital, the growth rate of GDP, and the proportion of income devoted to physical capital accumulation is much lower in African countries than the world average. Table I also shows large differences in the demographic structures in the two samples. African countries have a larger proportion of population under the age of 15 and a smaller proportion of their population over age 64 as compared to the averages for the entire sample.

## 4 Statistical Results

Before we present and discuss the estimates in Table III, we present and discuss a cross country OLS growth regression that tests, in a simple way, to see if the growth impacts of health and education in Africa are different from those of other parts of the world. The idea is to interact an African dummy variable with health and education variables and test to see if the interaction terms are jointly different from zero. The cross-national regression is run over the averages of the variables during the entire sample period so there are a total of 131 observations for this regression. The results of the OLS regressions are presented in Table II. Column 2 presents the estimates without *edu* as a regressor while column 3 presents the estimates with education as an added regressor. The growth equation explains a significantly large proportion (between 50% and 60%) of the cross-national variation in the growth rate of GDP. Most of the coefficient estimates have the expected signs and are statistically significantly different from zero. For the model that includes *edu*, the coefficients of *k*, *life*,  $\dot{x}$ , *popgro* are positive and significantly different from zero at  $\alpha = .01$  or better. The coefficient of  $y_0$  is negative and significant at  $\alpha = .10$ . The coefficients of *edu* is significant at  $\alpha = .05$  but that of *calorie* is insignificant. For the equation that excludes *edu*, the coefficients of *k*, *calorie*,  $\dot{x}$  and *popgro* are positive and significantly different from zero

at conventional levels. However, the coefficients of *life* and  $y_0$  are not significant. The coefficient of *popgro* is positive and significant but less than unity. The OLS estimates suggest that human capital has a positive and statistically significant impact on the growth rate of real GDP.

Do the growth effects of health and education in Africa differ from the growth impacts of these variables in other parts of the world? None of the African dummy interaction terms in Table II has a significant coefficient even at the 20% level. In addition,  $F$  tests to test the null hypothesis that all the interaction terms are jointly equal to zero produce  $F$  statistics of 0.7911 and 0.706 for the equation that includes *edu* and the one that excludes it, respectively. With 3, 81, and 2, 122 degrees of freedom respectively, we cannot reject the null at any confidence level.<sup>6</sup> From the cross-national OLS estimates of the growth equation, we cannot conclude that the two components of human capital we use here—education and health—have differential growth impacts in Africa than in other parts of the world.

It is possible that our conclusions from the OLS estimates are incorrect since the OLS estimates may be biased and inconsistent as discussed in Section II above. We therefore use the dynamic panel estimator to estimate the growth equation and test to see if the coefficient estimates from the African sample are different from those from the entire sample. The dynamic panel estimates of the growth equation without *edu* as a regressor are presented in Table III. Columns 2 and 3 present the estimates for the African sample while columns 4 and 5 present the estimates for the entire sample. Columns 2 and 4 present the estimates in first difference while columns 3 and 5 present the estimates in orthogonal deviation. The regression statistics of the dynamic panel estimates indicate that the equation is correctly specified. In particular, there is no evidence of serial correlation, the joint test of significance indicates that the variables are jointly significant and the Sargan test statistic indicates that the instrument vector is the correct one and the model is correctly specified. The Hausman test indicates that not all regressors are exogenous hence the dynamic panel estimator is the correct estimator to use to estimate the growth equation.

Coefficient estimates of the dynamic panel estimator have the expected signs and are generally precisely estimated. The coefficients of  $k$ ,  $\dot{x}$ , and *popgro* are positive and significantly different from zero at  $\alpha = .05$  or better in both the total and African samples. These coefficient estimates are in accord with prior expectations and similar to those obtained by earlier researchers. The fact that the coefficient of *popgro* is significantly less than unity implies that the growth rate of per capita income is negatively correlated with the growth rate of population. The coefficient of  $y_0$  is

negative but only significant in the total sample. The coefficient of *calorie* in all specifications in both samples is positive, and significantly different from zero at  $\alpha = .01$ , suggesting that there is a strong and positive correlation between average caloric intake and the growth rate of GDP. The coefficient of *life* is positive and significant at  $\alpha = .05$  or better in three of the four estimates, indicating a positive and significant correlation between life expectancy and the growth rate of GDP. The positive and significant coefficients of *life* and *calorie* indicate that health human capital has positive and significant effect on the growth rate of real GDP.

Does health human capital have a different impact on the growth rate of real GDP in African countries than in other parts of the world as some researchers have suggested? The estimates in Table III suggest that health human capital as measured by *calorie* and *life* has positive and highly significant effect on the growth rate of GDP in both Africa and other parts of the world. Any differential effect will be one of differences in magnitude rather in direction. Inspection of the coefficient estimates indicate that *calorie* has a larger absolute impact on the growth rate of GDP in Africa than in the larger sample while *life* has a larger absolute growth impact in the total sample as compared to the African sample. These estimates may suggest that *life* and *calorie* have different growth impacts in African countries than elsewhere in the world. We used a Hausman test to see if the estimates from the African sample differ from the estimates from the whole sample. The calculated  $\chi^2$  statistics are 2.8183 and 4.2172 for the first difference and orthogonal deviation estimates respectively. With 6 degrees of freedom, we fail to reject the null hypothesis that estimates from the African and the larger samples are the same. This result is similar to the results from the cross-national estimates that the impact of human capital on the growth rate of GDP in African countries is not different from the growth impact of human capital in the world as a whole.

The results in Table III suggest that there is no significant difference in the growth effect of health human capital in African countries relative to its effect on income growth in other parts of the world. However, it is possible that the results in Table III are biased. The estimates presented in Table III exclude education human capital from the growth equation. We present the dynamic panel estimates of the growth equation that includes *edu* as an additional regressor in Table IV. These estimates are based on smaller sample sizes (692 for total and 205 for Africa) than those presented in Table III. Columns 2 and 3 present the estimates for the African sample while columns 4 and 5 present the estimates for the total sample. As in Table III, columns 2 and 4 are the first

difference estimates while columns 3 and 5 are the orthogonal deviation estimates. The regression statistics indicate that the model fits the data relatively well. In particular, the Sargan statistic indicate that the model is correctly specified and the instrument vector used to estimate the model is appropriate. There is no evidence of serial correlation and the Hausman test indicates that not all the regressors can be treated as exogenous, hence the dynamic panel estimator is the appropriate estimate to be used to estimate the growth equation.

As in Table III, the coefficients of  $k$  and  $\dot{x}$  are positive, relatively large and significantly different from zero in all specifications in the two samples. The coefficient of  $y_0$  is negative but is significant only in the total sample. The coefficient of *calorie* is positive and significant in all samples. The coefficient of *life* is positive and significant in both estimates in the total sample and positive and significant in the orthogonal deviation estimates in the African sample. It is, however, not significant in the first difference equation in the African sample. *edu* has a positive, relatively large and significant coefficient in both specifications and samples. This implies that education human capital has a positive and significant effect on the growth of GDP in Africa and elsewhere, after controlling for the effects of health human capital and other growth enhancing factors. We also note that the inclusion of *edu* in the growth equation does not, in general, *qualitatively* change the coefficient estimates on the health human capital and other variables.

The estimates in Table IV show that human capital as measured by health and education has a significantly positive effect on the growth of GDP. In addition to the individual coefficient estimates, a Wald test to test the null hypothesis that human capital (*life*, *calorie*, *edu*) do not contribute to the explanation of the variance in the growth rate of GDP produced  $\chi^2$  statistics of 627, 585, 1053, and 1045 for the first difference and orthogonal deviation estimates for Africa and the full sample respectively. These statistics are far into the rejection region, hence we reject the null at any reasonable confidence level. The Wald test statistics and the significant coefficients of the human capital variables lead us to conclude that human capital positively and significantly affect the growth rate of GDP in both Africa and the world as a whole; results that are similar to those we obtained in Tables II and III.

Does human capital have differential growth in African compared to the world average in this more expanded measure of human capital? The coefficient estimate of *calorie* is larger in absolute magnitude in the African sample than in the total sample, suggesting that *calorie* has a greater growth impact in Africa than in the rest of the world. However, pair-wise comparison of the two

sets of estimates indicate that there is no statistically significant difference between the estimates of the coefficient of *calorie* in the African sample and the estimate in the whole sample. We can make similar statements about the coefficient estimate for *life* in both samples. The coefficient of *edu* differs in absolute magnitude between the African sample and the world sample. However, it is only in the orthogonal deviation estimates that the difference is marginally significant at  $\alpha = .10$ . A Hausman test to test the null hypothesis that the coefficient estimates in the African sample and that of the larger sample are equal produced  $\chi^2$  statistics of 5.8962 and 7.2161 for the first difference and the orthogonal deviation estimates respectively. With 7 degrees of freedom each, we cannot reject the null at any reasonable level of confidence. The tentative conclusion from this exercise is that the effect of human capital on economic growth in Africa is not different from its effect on economic growth elsewhere.

The estimates presented in Tables II-IV indicate that human capital, as proxied by health human capital and education human capital, has significantly positive effects on the growth rate of real GDP in Africa and other parts of the world. The results suggest that while the absolute magnitude of the individual coefficient estimates of the measures of health and education human capital may differ between the African countries and the rest of the world, there is no evidence that human capital has growth impact in Africa that is *significantly different* from the growth impact of these variables in the rest of the world. Our results imply that, at least as far as the growth effects of human capital is concerned, Africa is not different from the rest of the world.

What are the implication of our results? From a research perspective, our results imply that the structure of economic growth, at least as it relates to the growth impact of human capital is not different from that other parts of the world. Researchers therefore need not try to find different theories for Africa's "difference". Perhaps researchers should focus on finding ways to increase the stocks of growth enhancing characteristics and on finding ways to increase the productivity of these growth characteristics. From a policy perspective, our results imply that the quest for faster economic growth should follow the pattern that has been successful elsewhere, pursue policies that favor increased accumulation of productive resources as well as policies that increase the productivity of productive resources.

## 5 Conclusion

This paper uses panel data and an endogenous growth framework to investigate whether human capital has a different effect on the growth of income as compared to the rest of the world. Using both a cross-sectional estimate and dynamic panel estimates, we find that the growth effect of human capital on economic growth in Africa is not significantly different from the growth impact of human capital in the rest of the world. Our results stand whether we measure human capital as health human capital, education human capital, or both. The implications are that researchers should focus on finding ways to better understand the growth prospects of African countries rather than explaining Africa's dismal growth performance in terms of the "African difference". Our results imply that African policy makers should focus on adopting and adapting "best practices" that have worked elsewhere in the world in order to enhance growth in African countries. They also imply that international development agencies should treat African countries the way they treat other countries of the world.

## 6 Notes

1. See World Bank, *World Development Report, 2000/2001*, (Washington DC: Oxford University Press, 2001).
2. See United Nations Development Program (UNDP), *Human Development Report, 2000*, (New York: Oxford University Press, 2000).
3. See *World Development Report, 2000/2001* in n. 1 above.
4. We represent the growth rate of aggregate GDP by  $g$  in order to distinguish it from the growth rate of per capita income ( $y$ ) as we have discussed above.
5. We note that this proxy assumes that the labor force participation ratio does not change very much over time. If it does, then labor force growth rate may differ from the growth rate of the population.
6. We ran regressions that included only combinations *calorie* and *edu* and *life* and *edu* as the human capital variables. We fail to reject the null that the growth effect of these variables in Africa are not different from those of other countries. The calculated  $F$  statistics are 0.7096, 0.9722, 1.1574, and 0.9873 respectively; statistics that will lead us to fail to reject the null.

## 7 References

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**Table I**  
**SUMMARY STATISTICS OF SAMPLE DATA**

VARIABLE	LABEL	All Countries		Africa	
		Mean*	Std. Dev.	Mean	Std. Dev.
GDP growth rate (%)	<i>g</i>	3.7854	3.2914	3.5354	3.5459
Calorie Intake (daily av.)	<i>calorie</i>	2530.91	543.1076	2248.40	319.8510
Investment/GDP (%)	<i>k</i>	19.6575	7.5714	16.9688	9.0431
Pop. Growth rate	<i>popgro</i>	2.0081	1.0822	2.6442	0.6782
Education (years)	<i>edu</i>	4.2754	2.8045	2.0139	1.4011
Life Expectancy (years)	<i>life</i>	59.5684	12.0889	48.3704	7.5339
Pop < 15/Population (%)	<i>s14</i>	34.9496	34.1343	44.0837	23.9771
Pop > 65/Population (%)	<i>s65</i>	5.6559	3.8955	3.1842	0.6906
Export Growth (%)	<i>x</i>	6.0279	6.9333	5.5737	8.1113
Per Capita GDP (1987 PPP)	<i>y</i>	5084.57	8162.84	1016.59	2285.02
	N	852		318	

\* these are unweighted averages.

**Table II**  
**OLS ESTIMATES OF CROSS SECTION GROWTH EQUATION**

Variable	Coefficient		Estimates	
	Without Education		With Education	
<i>k</i>	0.0893***	(3.000) <sup>+</sup>	0.0941***	(3.0516)
<i>calorie</i>	0.0011***	(2.6147)	-0.0001	(0.1765)
<i>life</i>	0.007	(1.3972)	0.0857***	(2.6513)
<i>ẋ</i>	0.1860***	(4.6910)	0.2984***	(7.2453)
<i>popgro</i>	0.9742***	(7.2282)	0.5469***	(2.8770)
<i>edu</i>	—		0.1224**	(2.2627)
<i>y<sub>0</sub></i>	-0.0406	(0.1669)	-0.0036*	(1.6903)
<i>Africa * calorie</i>	-0.0007	(0.680)	0.0002	(0.2501)
<i>Africa * life</i>	0.0216	(0.5001)	-0.0165	(0.3601)
<i>Africa * edu</i>	—		0.2506	(1.1021)
N	131		91	
<b>F statistic</b>	15.40		13.91	
<b>Adjusted R-square</b>	.4919		.5865	
<b>F H<sub>0</sub>: Africa interact. terms = 0</b>	0.706	[2,122]	0.7911	[3,81]

+ absolute value of “t” statistics in parentheses.

\* 2-tail significance at  $\alpha = .10$

\*\* 2-tail significance at  $\alpha = .05$

\*\*\* 2 tail significance at  $\alpha = .01$

Table III

## GMM ESTIMATES OF GROWTH EQUATION: NO EDUCATION

Variable	Coefficient		Estimates	
	African	Countries	All	Countries
	First Difference	Orth. Deviation	First Difference	Orth. Deviation
$k$	0.1041*** (5.3636) <sup>+</sup>	0.1063*** (5.3434)	0.0435** (2.0674)	0.0729*** (3.5994)
$calorie$	0.0023*** (3.1690)	0.0024*** (3.2265)	0.0015*** (2.6405)	0.0014*** (3.3869)
$life$	0.0457** (2.5003)	0.0434** (2.2343)	0.1042 (1.5138)	0.0326** (2.5713)
$\dot{x}$	0.1714*** (4.2184)	0.1583*** (3.7097)	0.5089*** (11.3153)	0.3928*** (11.2467)
$popgro$	0.7403*** (4.0727)	0.8155*** (6.4166)	0.3411*** (2.7051)	0.5196*** (6.6588)
$y_0$	-0.0001 (0.5290)	-0.0001 (0.6324)	-0.0002* (1.9479)	-0.0002*** (2.6885)
N	318	318	852	852
<b>1st order ser. corr.</b>	0.948 [44]	1.284 [44]	0.356 [113]	0.806 [113]
<b>2nd order ser. corr.</b>	0.828 [38]	0.973 [38]	-0.44 [102]	-0.519 [102]
<b>Jt. test of sig.</b>	263.2797 [6]	419.349 [6]	311.264 [6]	317.103 [6]
<b>Sargan test</b>	22.274 [23]	23.185 [23]	19.794 [23]	24.344 [23]
<b>Jt. sig. of time dums.</b>	136.367 [6]	148.584 [6]	52.135 [6]	90.451 [6]
<b>Hausman <math>m</math></b>	84.392 [6]	108.381 [7]	218.228 [6]	198.249 [7]
<b>Wald Test [life, calorie]</b>	201.32	236.154	653.540	553.903

+ absolute value of asymptotic “t” statistics calculated from heteroskedastic consistent standard errors in parentheses.

\* 2-tail significance at  $\alpha = .10$

\*\* 2-tail significance at  $\alpha = .05$

\*\*\* 2 tail significance at  $\alpha = .01$

**Table IV**  
**GMM ESTIMATES OF GROWTH EQUATION: WITH EDUCATION**

Variable	Coefficient		Estimates	
	African First Difference	Countries Orth. Deviation	All First Difference	Countries Orth. Deviation
<i>k</i>	0.1248*** (3.9782) <sup>+</sup>	0.1268*** (6.2373)	0.0441*** (3.1956)	0.0525** (2.5103)
<i>calorie</i>	0.0043* (1.8147)	0.0029*** (3.2265)	0.0020** (2.5465)	0.0018** (1.9678)
<i>life</i>	-0.0125 (0.3972)	0.0411** (2.0044)	0.2268*** (3.4723)	0.2336*** (3.7840)
<i><math>\dot{x}</math></i>	0.3997*** (4.5059)	0.3287*** (6.3029)	0.4255*** (11.3153)	0.4045*** (9.4662)
<i>popgro</i>	0.8042* (4.2682)	0.9979*** (8.3192)	0.3039*** (2.5877)	0.3303*** (2.8738)
<i>edu</i>	0.3750*** (5.3977)	0.5633*** (3.0489)	0.2860** (2.1327)	0.3465** (2.4373)
<i>y<sub>0</sub></i>	-0.00001 (0.2069)	0.00001 (0.0632)	-0.0002** (1.9903)	-0.0002** (2.1978)
N	205	205	692	692
<b>1st order ser. corr.</b>	1.139 [29]	1.117 [29]	0.815 [92]	0.823 [92]
<b>2nd order ser. corr.</b>	1.008 [27]	0.974 [27]	0.317 [89]	0.524 [92]
<b>Jt. test of sig.</b>	635.473 [7]	694.683 [7]	470.3609 [7]	477.879[7]
<b>Sargan Test</b>	11.118 [15]	11.126 [15]	28.773 [29]	24.852 [29]
<b>Jt. sig. of time dums.</b>	208.581 [6]	174.747 [6]	62.962 [6]	76.962 [6]
<b>Hausman <i>m</i></b>	128.814 [6]	148.328 [7]	198.218 [6 ]	229.842 [7 ]
<b>Wald Test [life, calorie, edu]</b>	627.202	585.751	1053.86	1045.430

+ absolute value of asymptotic “t” statistics calculated from heteroskedastic consistent standard errors in parentheses.

\* 2-tail significance at  $\alpha = .10$

\*\* 2-tail significance at  $\alpha = .05$

\*\*\* 2 tail significance at  $\alpha = .01$