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HUMAN CAPITAL AND ECONOMIC GROWTH: IS AFRICA DIFFERENT?

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This paper investigates the difference in growth effects of human capital in African countries and the rest of the world. Using an expanded neoclassical growth model, panel data, a dynamic panel estimator and a broader definition of human capital including both health and education, we find that the effect of human capital on the growth rate of per capita GDP in Africa does not differ significantly from the growth impact of human capital in the rest of the world. Our results suggest that Africa does not grow any differently than 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 suggest that Africa should be treated like any other part of the world and that researchers and policy makers alike should forget about the "African difference," and formulate more efficient growth policies for Africa.

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I. Introduction

This paper investigates one aspect of the "African difference" that has been observed by some researchers: it uses panel data and a dynamic panel estimator to investigate whether the growth impact of human capital in African countries differs from the growth impact of human capital in other parts of the world. While the source of the "African difference" may be complex and multivariate, we restrict our attention in this paper to differences in the growth impacts of human capital mainly because of the importance given to human capital in the recent empirical growth literature. We investigate the possible difference by estimating an expanded neoclassical growth equation with both African and world samples and test to see if the two sets of estimates are the same. We measure human capital broadly to include both education and health in this study. This approach is different from most of previous studies of the impact of human capital on growth that have focused exclusively either on education or health. The use of the dynamic panel estimator also allows us to account for the possible endogeneity of health and other regressors in order to obtain consistent estimates. To our knowledge, this is the only study that uses two dimensions of human capital to investigate differential growth effect of human capital in Africa and other parts of the world.

Investigating a possible differential effect of human capital in economic growth in Africa is of policy as well as research interest. If human capital is associated with a relatively higher (lower) income growth rate in African countries than the rest of the world, then at the margin, African countries have to increase (decrease) their stocks of human capital relative to other factors than the rest of the world in order to achieve fast growth rates. This is especially important at a time when African leaders have set a GDP growth rate target of 7% per annum in the first half of the 21st century in a bid to reduce the massive poverty rates as enshrined in the aims and objectives of the New Partnership for African Development (NEPAD). The framers of NEPAD envision that most of this economic growth will be achieved through building and harnessing Africa's human capital. The assumption is realistic if human capital plays the same role in African economic growth as it does elsewhere. It is unrealistic if the growth impact of human capital does not have as much growth impact in Africa as Block (2001) argues. Investigating the possible differential growth effect of human capital will therefore help to inform the current debate on African economic growth.

One of the important conclusions of modern economic growth research is the importance of human capital in the growth process. Endogenous growth theory suggests that human capital is the source of innovation and technical progress, which are the ultimate sources of economic growth. To the extent that institutions are human creations, human capital can also be considered the source of efficient institutions that are necessary to create incentives to invest in research and development. The expanded neoclassical growth model sees human capital as probably the most important input in the growth process. Empirical evidence support the importance of human capital in economic growth (for example, see Barro 1991 and 1996, Bhargava et al. 2001, Mankiw, Romer and Weil 1992, Gyimah-Brempong and Wilson 2003, Bloom, Canning and Sevilla 2003, Bloom, Canning, and Malaney 2000 and Mayer 2001). Of course, not all researchers agree that all human capital has a positive impact on economic growth rate. For example, Prichett (2001) argues that increased education has not translated into faster growth or higher incomes in low income countries generally and Africa in particular.

Investigating differential growth effects of human capital in Africa has policy implications. Given the low income levels, pervasive poverty rates and rapidly growing populations, African countries have to grow very fast in order to make a dent in reducing poverty. This will imply faster accumulation of resources in this part of the developing world. If we find that human capital affects growth in Africa less than it does in the rest of the world, then the quest for increased growth in Africa should be found elsewhere. On the other hand, if we find that human capital affects economic growth in Africa in the same way it affects growth elsewhere (or has a higher growth impact), then a case can be made for increasing Africa's stock of human capital as a way to improve economic performance in the region.

Economic performance in Africa has been abysmal. In 2001, per capita GDP in Sub-Saharan Africa was only 43% of the average for the developing world and 25% of the world average.[1] Sub-Saharan Africa's Human Development Index (HDI) in 2001 was 0.47, only 71% and 65% of the developing world's and total world's averages of 0.66 and 0.72 respectively.[2] Africa is the only region in the developing world where per capita income declined during the 1991-2000 period. Indeed, during the 1998-2001 period, per capita income in African countries declined at the rate of 0.3% per annum; this compares to the world and low-income countries per capita income average growth rates of 1.3% and 2.5% respectively.[3] This poor performance has taken place in spite of the fact that until recently, African countries had made enormous progress in human capital formation. For example, between 1960 and 1995, life expectancy at birth and adult (defined as 15 years old and above) literacy rates increased from 40 to 46.9 years and 28.2% to 62.4% respectively while infant mortality decreased from 180 per 1000 to 107 per 1000.[4]

The poor economic performance of African countries 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 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, and Easterly and Levine 1997, among others). Block shows that the effects of many traditional growth factors are different in Africa compared to the rest of world and factors that improve institutional quality elsewhere do not have those effects in Africa. Why might the economic growth process in Africa be different from those of other parts of the world? Some researchers have suggested that geography may explain most of the “African effect” (Sachs and Warner 1997; Bloom and Sachs 1998). Africa, they argue, is mostly tropical with poor soils incapable of supporting sustained and productive agriculture, and the 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 0.3 percentage points. A large number of African countries are also landlocked with no access to navigable waters, a situation that is supposed to retard economic growth because of high transportation cost (Sachs and Warner 1997).[5]

Other researchers argue that Africa’s growth tragedy can be attributed to political instability and institutional weakness (Collier and Gunning 1999, Londregan and Poole 1990, Block 2001, Gyimah-Brempong and Traynor 1999 and Temple 1998, among others). The story is that political instability increases uncertainty and risk, hence destroys the environment in which to invest. If this is the case, then the African experience may not be unique since political instability everywhere results in poor growth performance (Alesina et al 1984; Barro and Sala-i-Martin 1995; Atardi and Sala-i-Martin 2003). Some researchers argue that the "African difference" can be explained by colonialism since colonialism led to the development of exploitative institutions (Price 2003). It is not clear why this should uniquely retard economic growth in Africa and not everywhere else since other parts of the world, including the fast growing regions of Asia, came under colonial domination. Finally Hoeffler (2002) and Bloom, Canning and Malaney (2000) suggest that the "African difference" is the result of inappropriate econometric methods and model specification.

If African countries grow differently, 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. Also efforts at structural reforms are doomed to failure since by definition, Africa is "different" and may therefore not respond to conventional economic growth strategies. 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 it has lower endowments of growth characteristics. In particular, Africa's human and physical capital stocks as well as institutions may be below the minimal threshold necessary for sustained growth. Indeed, Atardi and Sala-i-Martin (2003) argue that Africa's growth tragedy of the 20th century can be explained by low endowments of human capital, poor external environment, and political instability. Growth theory, after all, suggests that initial conditions matter for cross-country differences in the growth rate of income. If that is the case, then policy should focus on how to increase the endowments of Africa's growth characteristics rather than treating Africa as different.

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 rest of the world. 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. It is also possible that endowments of growth characteristics in African countries are below the minimum threshold that will make Africa grow as fast as the rest of 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. Our results suggest that Africa is not a special case; therefore African policy makers should formulate, adopt and effectively implement appropriate growth enhancing policies to achieve faster economic growth as other parts of the world have done.

The rest of the paper is organized as follows: Section 2 briefly presents the empirical growth equation which includes both education and health human capital 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.

II. Model

We use an expanded neoclassical growth equation to investigate the possibility of differential growth impact of the stock of human capital in Africa and other parts of the world. Following the modern growth literature, (Barro 1991, Caselli et al 1996, Romer 1990, Jones 1997, Benhabib and Speigel 1994, Krueger and Lindhal 2001 and van Zorn and Muysken 2001, among others), we make aggregate output a function of technology (A), labor (L), the stocks of physical capital (K), health and education human capital (H E), and environment factors ($\mathbf{Z}$). While human capital has been broadly defined in the theoretical growth literature, empirical growth studies 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 of income (Shultz 1999, Over 1992, Bhargava 2001, Gallup and Sachs 2000, Sachs and Warner 1997, Knowles and Owen, 1995, 1997; Weil, 2001; Mayer, 2001; Bloom, Canning and Malaney 2000, Bloom, Canning, and Sevilla 2003 and Gyimah-Brempong and Wilson 2004). These studies find that human capital, whether measured as education or health, has significantly positive effects on income growth. However, with the exception of Bloom, Canning and Malaney (2000), Bloom, Canning and Sevilla (2003) and Gyimah-Brempong and Wilson (2004), all the studies mentioned above measure human capital as *either* education or health. We follow this group of researchers and include *both* the education and health components of human capital in our growth equation. 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 the 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 rates of the arguments of the per capita output equation. We assume that a constant proportion of output is devoted to the formation of both physical and human capital (the savings rate). Following the "new" 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 as well as policy variables in **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:

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

where s is the savings rate and all other variables are as defined above. The growth rate of per capita income equation has **Z**, an aggregate variable, as an argument rather than the per capita environmental variable. This reflects our assumption that because of externalities, it is the aggregate environmental variable that determines 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 by 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 **Z** vector includes variables that previous research has shown to influence the growth rate of income. These include initial income (y_0) and export growth. 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 exports and the externalities generated by the export sector. We follow these researchers and include the growth rate of exports ($\dot{x}$) as an additional regressor.

The growth rate equation we estimate is:

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

where ξ is a stochastic error term and all other variables are as defined above. We expect the coefficients of k, $life$, $calorie$, edu and $\dot{x}$ to be positive in the growth equation. If conditional convergence operates in our sample, we expect the coefficient of y_0 to be negative.

III. Estimation Method and Data

In this section, we describe the data used to estimate the growth equation in (3) and discuss the estimation method. Sub-section 3.1 discusses the estimation method while sub-section 3.2 describes the data.

A. *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 2000 period. The error term consists of a country fixed effect and a stochastic error term; i.e. $\xi = \eta_i + \epsilon_{it}$, where η_i is country fixed effect and ϵ_{it} is the usual white noise. In addition to fixed effects, some of the regressors, such as k and $\dot{x}$ may be endogenous. Because of correlated fixed effects and the endogeniety of regressors, the orthogonality condition 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 the orthogonality condition through appropriate differencing of the data. However, because the equation contains endogenous regressors as well as the effects of lagged endogenous variables, 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.

Arellano and Bond (1991) have proposed a dynamic panel data estimator (DPD98) based on General Method of Moments (GMM) methodology that optimally exploits the linear moment restrictions implied by the dynamic panel growth model. 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 DPD98 estimator is probably the most appropriate estimator for growth equations since it is generally very difficult to find appropriate instruments for endogenous variables in growth regressions. Equations can be estimated from the levels of the variables or from the first differences of the variables. For the difference estimator, the variables are measured as first differences and the lagged value of the levels of the variables are used as appropriate instruments. For example for the equation $\Delta y_{i3} = \alpha \Delta y_{i2} + \beta \Delta x_{i3} + \Delta \xi_{i3}$, we use y_{i1}, x_{i1}, and x_{i2} as instruments. Instruments for $\Delta_y i4$ and other equations are constructed similarly. The dynamic GMM estimator is given as:

$$\hat{\theta} = (\mathbf{\bar{X}'ZA_N Z'\bar{X}})^{-1}\mathbf{\bar{X}'ZA_N Z'\bar{y}}$$

where $\hat{\theta}$ is the vector of coefficient estimates on both the endogenous and exogenous regressors, $\mathbf{\bar{X}}$ and $\mathbf{\bar{y}}$ 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 GMM 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 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 subdiagonal, 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 θ. The optimal choice of A_N for the two step estimator is given as: $A_N = \hat{V_N} = N^{-1}\sum_i Z_i'\hat{\bar{v}}_i\hat{\bar{v}}_i Z_i$ where $\hat{v}_i$ are the residuals obtained from a preliminary consistent estimate of θ. The one- and two-step estimators will be asymptotically equivalent if the error terms are spherical. There is the tendency for the two-step estimator to underestimate the standard errors of estimates hence provide a false sense of precision under some circumstances. The usual practice is to estimate with the two-step estimator but base hypothesis tests on the one-step estimator's statistics. We follow this practice in this paper.

Blundell and Bond (1998) argue that lagged levels of variables are likely to be weak instruments for current differenced variables when the series are close to random walk. Under these conditions, the differenced GMM estimates are likely to be biased and inefficient. They suggest the more efficient system GMM estimator (SYS-GMM), which combines the difference equation and a levels equation in which suitably lagged differenced variables ($\Delta y_{i,t-1}$ and $\Delta x_{i,t-1}$) are the appropriate instruments. The SYS-GMM estimator is consistent and more efficient than the first difference estimator provided there is no significant correlation between the differenced regressors and country fixed effects (i.e. $E(\Delta x_{it}\eta_i) = 0$) and the initial condition $E(\Delta y_{i2}\eta_i) = 0$ is satisfied. If these conditions are satisfied then the $T-2$ linear moment restrictions $E(u_{it}\Delta y_{i,t-1}) = 0$ for $t = 3, 4, ...T$ are valid. The efficiency gains of the SYS-GMM estimator will depend on the degree to which the series is close to a random walk. We test the validity of the additional instruments in the SYS-GMM with a Difference Saragan test statistic that compares the first difference GMM estimates with the SYS-GMM estimates.

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. 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 $j = 2, ..., t-1$, 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 DPD98 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.

B. *Data*

The endogenous variable in the model is the growth rate of real per capita income ($\dot{y}$) which we measure as the annual growth rate of real GDP per capita in a country. The explanatory variables are investment rate (k), health human capital, education human capital, the growth rate of real exports ($\dot{x}$) and initial per capita income (y_0). 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. For example, y_0 for the 1960-1964 period is real per capita GDP in 1960. We measure $\dot{x}$ as the annual growth rate of real export earnings in a country. 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 period. We choose to measure *edu* as the educational attainment of the working age population rather than enrollment ratios that have been used by some researchers because of the long lag between enrollment and employment and the fact that human capital that is used in production is that of the working age population rather than those enrolled in school. While we note that not all education human capital is productively employed and hence contributing to growth, we assume that a given proportion of the education human capital is productively employed and therefore the larger the stock of a nation's education human capital, the greater its contribution to the nation's economic growth, all things equal.

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 by other researchers (Weil 2001) to measure health human capital in empirical research. None of these measures is an ideal measure of health human capital for empirical growth studies 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, the component of health human capital that is likely more relevant to growth than longevity. We proxy health human capital by two variables—life expectancy at birth ($life$) and average daily caloric intake ($calorie$). The former reflects the stock of health human capital as indicated by longevity while the latter may reflect 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 less than 15 years old ($s14$) or greater than 65 years old ($s65$).

Data for estimating the growth equation were obtained from a variety of sources. Data for $\dot{y}$, $\dot{x}$, $life$, and k were obtained from the World Bank's *World Development Indicators, 2000* (World Bank 2000). Data for y_0 were obtained from the *World Development Indicators, 2000* and Summers and Heston's *Penn World Tables*, Mark 5.6. The data for edu were obtained from Barro and Lee (2000) while the $calorie$, $s14$, and $s65$ 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 2000.[6] To reduce the effects of business cycles on our results, we took five year averages of the variables, as is usually done in 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 a second sub-sample that excluded *edu* from the data set. The sample with *edu* had a total of 692 (205) observations for the total (African) sample. We present estimates based on each of the samples.

Summary statistics of the sample data are presented in Table I. Average income, life expectancy, education human capital, caloric intake, export growth rate, and physical capital investment rate are much higher in the larger sample than in the African sample. Per capita income in African countries is only about 20% of the average for 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 a 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 are 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. We note that variation in the growth-enhancing variables are much higher, as indicated by the coefficient of variation, than their counterparts in the larger sample. Table 1 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.

Table 1
Summary Statistics of Sample Data

	All Countries		Africa	
Variable	**Mean***	**Coef. of Var.**	**Mean***	**Coef. of Var.**
GDP growth rate (%) ($\dot{y}$)	2.39	96.06	0.80	441.97
Calorie Intake (daily av.) (*calorie*)	2530.91	21.46	2248.40	14.23
Investment/GDP (%) (k)	19.66	38.52	16.97	53.29
Education (years) (*edu*)	4.28	65.60	2.01	69.57
Life Expectancy (years) (*life*)	59.57	20.29	48.37	15.58
Pop < 15/Population (%) (*s14*)	34.95	96.67	44.08	54.39
Pop > 65/Population (%) (*s65*)	5.66	68.87	3.18	21.69
Export Growth (%) ($\dot{x}$)	6.03	115.02	5.57	145.53
Per Capita GDP (1987 PPP) (y)	5084.57	160.54	1016.59	224.90
N	852		318	

*Means are unweighted averages

IV. Statistical Results

We use the dynamic panel estimator (DPD98) to estimate the growth equation in (3) and test to see if the coefficient estimates from the African sample are different from those from the entire sample. We use both the first difference and SYS-GMM to estimate (3). We test for the differential effects of the growth factors between African countries and the rest of the world in two ways. First, we estimate the growth equation with the full sample and the African sample respectively and compare the estimated human capital coefficients to see if they are equal. Second, we pool the African and the rest of world sample to estimate the growth equation but add African dummy interaction terms with the human capital variables. If the effect of human capital on economic growth in Africa is different from that of the rest of the world, the African dummy interaction terms should be significantly different from zero, all things equal. If the effect of human capital on economic growth in Africa is different from its effect on growth in the rest of the world, we expect both approaches to lead to the same result, hence the two approaches will act as a check on each other.

Coefficient estimates of the growth equation without *edu* as a regressor are presented in Table 2. 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 first difference estimates while columns 3 and 5 present the SYS-GMM estimates. The regression statistics indicate that the equation is correctly specified. In particular, there is no evidence of serial correlation, the joint test of significance leads us to reject the null hypothesis that all slope coefficients are jointly equal to zero at $\alpha = .01$ and the Sargan test statistic indicates that the model is correctly specified and the overidentifying restrictions cannot be rejected. The Difference Sargan test statistics indicate that the additional instruments in the SYS-GMM equation are appropriate. The Hausman exogeniety test statistic indicates that not all regressors are exogenous hence the DPD98 estimator is the appropriate estimator for the growth equation. The regression statistics of the first difference and SYS-GMM estimates suggest that both approaches produce consistent and relatively efficient estimates of the growth equation in (3). The coefficient estimates from both the first difference and SYS-GMM equations are generally similar in magnitude although the SYS-GMM coefficients are more precisely estimated than the first difference estimates. It appears that it does not matter whether we base our discussions and conclusions on the first difference or SYS-GMM estimates. Our subsequent discussions will therefore refer to both estimates.

Table 2
GMM Estimates of Growth: No Education

	African Countries		**All Countries**	
	First Diff	SYS-GMM	First Diff	SYS-GMM
k	0.10***	0.11***	0.04**	0.07***
	(5.36)+	(5.34)	(2.07)	(3.60)
$calorie$	0.0023***	0.0024***	0.0015***	0.0014***
	(3.1690)	(3.2265)	(2.6405)	(3.3869)
$life$	0.05**	0.04**	0.09***	0.05***
	(2.50)	(2.23)	(2.81)	(3.57)
$\dot{x}$	0.17***	0.16***	0.51***	0.39***
	(4.22)	(3.71)	(9.32)	(11.25)
y_0	-0.0001	-0.0001	-0.0002**	-0.0002***
	(0.5290)	(0.6324)	(1.9479)	(2.6885)
N	318	318	852	852
1st order serial correlation	0.95 [44]	1.28 [44]	0.36 [113]	0.81 [113]
2nd order serial correlation	0.83 [38]	0.97 [38]	-0.44 [102]	-0.52 [102]
Jt. test of significance	263.28 [5]	419.35 [5]	311.26 [5]	317.10 [5]
Sargan test	22.27 [23]	23.19 [29]	19.79 [23]	24.34 [29]
Diff. Sargan	–	8.90 [7]	–	9.13 [7]
Jt. significance of time dummies	136.37 [6]	148.58 [4]	52.14 [6]	90.45 [4]
Hausman m	84.39 [5]	108.38 [5]	218.23 [5]	198.25 [5]
Wald Test (life, calorie)	201.32 [2]	236.15 [2]	653.54 [2]	553.90 [2]

+ absolute value of asymptotic "t" statistics calculated from heteroskedastic consistent standard errors in parentheses.
* 2-tail significance at $\alpha = .10$; ** at $\alpha = .05$ and *** at $\alpha = .01$.

All coefficient estimates have the expected signs and are generally precisely estimated. The coefficients of k and $\dot{x}$ are positive and significantly different from zero at $\alpha = .05$ or better in both the total and African samples. This suggests that investment rate and the growth of export earnings are positively and significantly correlated with the growth rate of per capita income. These coefficient estimates are in accord with prior expectations and similar to those obtained by earlier researchers. The coefficient of y_0 is negative but only significant in the total sample. This indicates that there is some evidence that conditional convergence operates in our sample.

The coefficient on *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 per capita income. In addition, Wald statistics to test the null hypothesis that $life$ and *calorie* do not help explain the variation in growth rates leads to a rejection of the the null at $\alpha = .01$. At the mean of the variables, a 1% increase in caloric intake is associated with about 0.20 percentage point increase in the growth rate of per capita income in African countries and the rest of the world. The coefficient on $life$ is positive and significantly different from zero at $\alpha = .05$ or better in all four estimates, indicating a positive and significant correlation between life expectancy and the growth rate of per capita income. At the mean of the variables, a 1% increase in life expectancy is associated with a 0.3–0.4 percentage point increase in the growth rate of per capita income in African countries and about 0.6 percentage point increase in the growth rate of per capita income in the rest of the world, all things equal. The positive and significant coefficients on $life$ and *calorie* indicate that health human capital has positive and significant effect on the growth rate of real GDP, all things equal.

Does health human capital have a different impact on the growth rate of real per capita income in African countries than in other parts of the world? The estimates in Table 2 suggest that health human capital as measured by *calorie* and $life$ has a positive and highly significant effect on the growth rate of per capita income in both Africa and other parts of the world. Any differential effect will be one of differences in magnitude rather than in direction. Inspection of the coefficient estimates indicate that *calorie* has a larger absolute impact on the growth rate of per capita income in Africa while $life$ has a larger absolute growth impact in the total sample. These estimates may suggest that $life$ and *calorie* have differential growth impacts in African countries than elsewhere in the world. If that is the case, one may conclude that the effects of health human capital on economic growth in African countries differs from its effect on economic growth in the rest of the world. However, to arrive at such a conclusion, one has to ensure that there is a *statistically significant difference* between the two sets of estimates.

We used a Hausman specification test to test whether the estimates from the African sample differ from the estimates from the whole sample. The calculated χ^2 statistics are 2.8183 and 3.2172 for the first difference and SYS-GMM estimates respectively. With 5 degrees of freedom, we fail to reject the null hypothesis that the estimates from the African and the larger samples are the same. In addition to testing for the equality of the full sets of regressors in both samples, we also tested for the joint equality of the coefficients of $life$ and *calories* in the African and total samples. The calculated χ^2 statistics are 1.87 and 2.03 for the first difference and SYS-GMM coefficients respectively. With 2 degrees of freedom, we conclude that there is no significant difference between the coefficient estimates of $life$ and *calories* in the African and world samples.

The results in Table 2 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. The estimates presented in Table 2 exclude education human capital as a regressor from the growth equation. The exclusion of *edu* as a regressor could possibly bias the coefficient estimates of *calorie* and $life$ in both samples towards zero, thus ensuring that we find no significant difference between the growth effects of human capital in the two regions. We test for the possibility that our results depend on the exclusion of *edu* from the growth equation by estimating an expanded growth equation that includes *edu* as an additional human capital indicator.[7]

We present the estimates of the growth equation that includes *edu* as an additional regressor in Table 3. These estimates are based on a smaller sample size (692 for total and 205 for Africa) than those presented in Table 2. 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 2, columns 2 and 4 are the first difference estimates while columns 3 and 5 are the SYS-GMM estimates. The regression statistics indicate that the model fits the data relatively well. In particular, the Sargan statistic indicates 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 exogeneity test indicates that not all regressors can be treated as exogenous, hence the DPD98 estimator is the appropriate one for the growth equation. The difference Sargan statistic indicates that we cannot reject the null hypothesis that the additional instruments in the SYS-GMM regression are valid.

Table 3
GMM Estimates of Growth: With Education

	African Countries		**All Countries**	
	First Diff	SYS-GMM	First Diff	SYS-GMM
k	0.12***	0.13***	0.04***	0.05***
	(3.98)+	(6.24)	(3.20)	(3.51)
$calorie$	0.0043*	0.0029***	0.0020**	0.0018***
	(1.8147)	(3.2265)	(2.5465)	(2.9678)
$life$	-0.01	0.04**	0.23***	0.23***
	(1.40)	(2.00)	(3.47)	(3.78)
$\dot{x}$	0.40***	0.33***	0.43***	0.40***
	(4.51)	(6.30)	(8.32)	(9.47)
edu	0.38***	0.56***	0.29**	0.35**
	(5.40)	(3.05)	(2.13)	(2.64)
y_0	-0.00001	-0.00001	-0.0002**	-0.0002**
	(0.2069)	(0.0632)	(1.9903)	(2.1978)
N	205	205	692	692
1st order serial correlation	1.14 [29]	1.12 [29]	0.82 [92]	0.82 [92]
2nd order serial correlation	1.01 [27]	0.97 [27]	0.32 [89]	0.52 [92]
Jt. test of significance	635.47 [6]	694.68 [6]	470.36 [6]	477.879[6]
Sargan Test	11.12 [18]	11.13 [27]	28.77 [29]	24.85 [38]
Diff. Sargan	–	9.86 [9]	–	11.07 [9]
Jt. significance of time dummies	208.58 [6]	174.75 [4]	62.96 [6]	76.96 [4]
Hausman m	128.81 [6]	148.33 [6]	198.22 [6]	229.84 [6]
Wald Test (life, calorie, edu)	127.20 [3]	284.75 [3]	128.86 [3]	109.43 [3]

+ absolute value of asymptotic "t" statistics calculated from hetero-skedastic consistent standard errors in parentheses.
* 2-tail significance at $\alpha = .10$; ** at $\alpha = .05$ and *** at $\alpha = .01$.

As in Table 2, 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 only significant in the total 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 per capita income in Africa and elsewhere, after controlling for the effects of health human capital and other growth-enhancing factors. The coefficient of *calorie* is positive and significant in both samples and in all specifications. With the exception of the first difference estimates in the African sample, the coefficient of $life$ is positive and significant in all specifications and samples. The coefficient of $life$ in the African sample is not significant at any reasonable level of confidence. While the inclusion of *edu* as an added regressor in the growth equation does not generally affect the sign or absolute magnitude of the estimates, they are less precisely estimated than their counterparts in Table 2. This is not surprising given that *edu* is positively correlated with some of the regressors. The inclusion of *edu* does not *qualitatively* affect our result that $life$ and *calorie* have significantly positive effects on income growth. This suggests that the estimates presented in Table 2 and the conclusion derived therefrom does not depend on the exclusion of education as a regressor in the growth equation.

The estimates in Table 3 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*) does not contribute to the explanation of the variance in the growth rate of GDP produced χ^2 statistics of 127.81, 284.75, 128.86, and 109.43

for the first difference and SYS-GMM estimates for Africa and the full sample respectively. These statistics are well within 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 affects the growth rate of GDP in both Africa and the world as a whole and there is no significant difference between the effect of human capital in Africa and the rest of the world—results that are similar to those we obtained in Table 2.

Does human capital have differential growth effect in African countries compared to the world average given 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 the possibility 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 make similar statements about the coefficient estimate for $life$ and *edu* in both samples. A Hausman test to test the null hypothesis that the coefficient estimates of *calorie*, $life$ and *edu* in the African sample are jointly not different from their counterparts in the larger (world) sample produced χ^2 statistics of 1.8967 and 2.1786 for the first difference and SYS-GMM respectively. With 3 degrees of freedom, we do not reject the null hypothesis at any reasonable confidence level.[8] Also, a Hausman test to test the null hypothesis of the equality of all coefficient estimates in the African sample and the world sample produced χ^2 statistics of 4.8962 and 5.2161 for the first difference and the SYS-GMM estimates respectively. With 6 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 2 and 3 suggest that the growth effects of human capital in African countries, however measured, is not different from its growth effect in the rest of the world. However, this conclusion is based on coefficient estimates from separate regressions for the world and African samples. It may be argued that coefficient estimates from the separate regressions from the African and the rest of the world samples are not strictly comparable, hence our conclusion may not be valid. To check the validity of this argument, we re-estimated the growth equation by pooling the samples from Africa and the rest of the world and then adding an African dummy interacted with the human capital variables to the growth equation. The differential growth effects of human capital on economic growth is given by the coefficients of the interaction terms.[9]

Coefficient from this equation are presented in Table 4. Column 2 presents the first difference estimates while columns 3 presents the SYS-GMM estimates. The regression statistics indicate that model fits the data relatively well. In general, the inclusion of the interaction terms does not change the *quality* of the estimates. The coefficient estimates of k and $\dot{x}$ are positive and significant while that of y_0 is negative and significant at $\alpha = .05$. The coefficients of $calorie$, $life$, and edu are positive and significantly different from zero at $\alpha = .05$ or better suggesting that human capital has a positive and significant effect on the growth rate of per capita income in Africa. We note that the magnitude and precision of the estimates in Table 4 are generally similar to their counterparts in Tables 2 and 3. This implies that pooling the data the data does not adversely affect our estimates.

Table 4
Growth Equation Estimates with African Interaction Terms

	First Difference	SYS-GMM
k	0.0444***	0.0525**
	(3.3987)	(3.8103)
$calorie$	0.0021**	0.0023***
	(2.5465)	(2.9678)
$life$	0.2007***	0.2016***
	(3.4723)	(3.9281)
$\dot{x}$	0.4255***	0.4045***
	(7.8153)	(8.9142)
edu	0.2860**	0.3465***
	(2.7128)	(3.2473)
y_0	-0.0002**	-0.0002**
	(1.9903)	(2.0071)
$africa * calorie$	0.0016	-0.0002
	(1.0287)	(0.9218)
$africa * life$	0.0517	0.0381
	(0.9027)	(1.2971)
$africa * edu$	0.0029	0.1008
	(0.9821)	(1.3129)
N	692	692
1st order serial correlation	0.82 [92]	0.82 [92]
2nd order serial correlation	0.32 [89]	0.52 [92]
Jt. test of significance	470.36 [6]	477.88 [6]
Sargan Test	28.77 [23]	24.85 [34]
Diff. Sargan	–	9.89 [11]
Jt. significance of time dummies	62.96 [6]	76.96 [4]
Hausman m	198.22 [6]	229.84 [6]
Wald Test (life, calorie, edu)	105.86 [3]	104.43 [3]

+ absolute value of asymptotic "t" statistics calculated from heteroskedastic consistent standard errors in parentheses.
* 2-tail significance at $\alpha = .10$; ** at $\alpha = .05$ and *** at $\alpha = .01$.

The coefficients of the African interaction terms, ($africa * calorie$, $africa * life$, $africa * edu$) are all positive. However, none of these coefficient estimates are significantly different from zero at any reasonable confidence level. Wald statistics to test the null hypothesis that all three coefficients are jointly equal to zero produced χ^2 statistics of 1.90 and 1.25 for the first difference and SYS-GMM estimates respectively. With 3 degrees of freedom, we do not reject the null hypothesis. We therefore conclude that the growth effect of human capital in African countries is not different from that of the rest of the world. These results are similar to those presented in Tables 2 and 3 above.

The estimates presented in Tables 2-4 indicate that human capital, as proxied by health human capital and education human capital, has significantly positive effects on the growth rate of real per capita income in Africa and other parts of the world. We find that there is no *qualitative* difference between the growth impact of human capital in African countries and other parts of the world. The results suggest that while the absolute magnitude of the estimates of individual coefficient of the measures of health and education human capital may *quantitatively* differ between the African countries and the rest of the world, there is no evidence that this difference is *significantly different* from zero in the statistical sense at any reasonable level of confidence. 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. Our results differ from those of researchers who find that Africa grows differently from the rest of the world (Block 2001, Gallup and Sachs 2000, Sachs and Warner 1997 and Barro 1991); it is, however, consistent with research that find that Africa does not grow differently from the rest of the world (Bloom et al 2000; Hoeffler 2002).

Why may Africa grow differently from the rest of the world? While we do not investigate this issue here, we briefly make references to other studies that try to explain why Africa may be prone to persistent slow growth. The transition from colonialism to nationhood in Africa has been associated with unusually high degree of political and institutional instability and frequent civil wars, and these have resulted in slow economic growth (Gyimah-Brempong and Traynor 1999, Collier and Gunning 1999 and Nkurunziza and Bates 2003, among others). Other researchers point to low stock of human capital as the source of Africa's slow growth relative to the rest of the world (Atardi and Sala-i-Martin 2003; Over 1994). While African countries have made tremendous progress in the provision of health and education since the 1960s, their stock of human capital is low compared to those of other parts of the world. Moreover, in health, there is evidence that the gains made between the 1950s to 1980s have began to erode as a result of the HIV/AIDS epidemic. Moreover, even the low stock of education human capital that does exist in Africa is not available to help in the growth effort since the most productive emigrate to high income countries. A third possible source of the "African difference" is poor or weak institutions (Collier and Gunning 1999; Easterly and Levine 1997). The story is that Africa possesses fewer growth-enhancing institutions than other parts of the world, thus it is not surprising that growth is slower in Africa. Finally, some researchers argue that any suggestion that Africa grows slower than the rest of the world because of any inherent "African difference," may be based on faulty methodology (Hoefler 2002) or model misspecification (Bloom et al 2000).

What are the implications of our results? From a research perspective, our results imply that the structure of economic growth in Africa, at least as it relates to the growth impact of human capital, is not different from that of other parts of the world. Researchers, therefore, need not try to find different theories to explain the perceived African "difference." Perhaps researchers should focus on finding ways to increase the stocks of growth enhancing characteristics and 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 these resources. More important, African countries should pursue policies that will keep Africa's scare human capital gainfully employed in Africa, rather than policies that encourage the most skilled to emigrate.

V. Conclusion

This paper uses panel data and an expanded neoclassical growth framework to investigate whether human capital has a different effect on the growth of income in African countries compared to the rest of the world. Using a dynamic panel estimator, we find that the growth effect of human capital in Africa is not significantly different from the economic growth impact of human capital in the rest of the world. Our results stand whether we measure human capital as health human capital or a combination of health and education human capital. The implications from our results 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 income growth in African countries. They also imply that international development agencies should treat African countries the way they treat other countries of the world.

Endnotes

[1]See World Bank, *World Development Report 2002*, Washington DC: Oxford University Press, 2002.

[2]See United Nations Development Program (UNDP), *Human Development Report, 2003*, New York: Oxford University Press, 2003.

[3]See *Wold Development Report, 2002* in n. 1 above.

[4]See United Nations Development Program (UNDP), *Human Development Report, 2003*, New York: Oxford University Press, 2003, and various issues of *World Development Report*, Washington, D.C.: Oxford University Press.

[5]We note that the African country with the best growth record in the last 20 years (even by world standards)—Botswana—is a completely landlocked desert country.

[6]The countries in the sample are: Albania, Algeria, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Belize, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cambodia, Cameroon, Canada, Cape Verde, Central African Republic, Chad, Chile, China, Colobia, Comoros, Democratic Republic of Congo, Congo

Republic, Costa Rica, Cote d'Ivoire, Cyprus, Denmark, Dominican Republic, Equador, Egypt, El Salvador, Equatorial Guinea, Ethiopia, Fiji, Finland, France, Gabon, Gambia, Germany, Ghana, Greece, Grenada, Gutemala, Guinea, Guinea-Bessau, Guyana, Haiti, Honduras, Hong Kong, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kuwait, Laos, Lebanon, Lesotho, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauitania, Mauritius, Mexico, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Panama, Papua New Guinea, Paraguay, Philippines, Poland, Portugal, Romania, Rwanda, Sao Thome and principe, Saudi Arabia, Senegal, Sychelles, Sierra Leone, Singapore, South Africa, Spain, Sri Lanka, Sudan, Suriname, Swaziland, Sweden, Switzerland, Syria, Tanzania, Thailand, Togo, Tunisia, Turkey, Uganda, United Arab Emirates, United Kingdom, United States of America, Uruguay, Venezuela, Vietnam, Yemen, Zambia, and Zimbabwe.

[7]We note that, as Gyimah-Brempong and Wilson (2004) show, *edu* and $life$ are positively correlated. Regressing $life$ on *edu* produced a coefficient of 0.26 and 0.13 for the African and total samples. Both estimates were significantly different from zero at $\alpha = .05$ or better.

[8]We ran regressions that included only combinations of *calorie* and *edu*, $life$ and *edu* as the measures of 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 0.71, 0.97, 1.16, and 0.99 respectively, which leads us to fail to reject the null.

[9]It is possible that the African dummy variable is correlated with the error terms, biasing the estimates. We admit that the approach we adopt here is a crude way of testing for the differential growth impact of human capital. This approach is only intended to be illustrative and intended as a supplement to the analysis presented in Tables 2 and 3.

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