A GROWTH MODEL OF SUB-SAHARAN AFRICA

Abstract

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Abstract

This paper studies growth in living standards in sub-Saharan African countries, as measured by long-term growth in real per capita GDP and long-term growth in an index of human development. A production function, an institutional approach, and a geographic model, as well as a combination of the three, are used to explain real per capita GDP growth. In addition, the growth in human development is modeled to provide a non-monetary measure of performance. The empirical findings indicate that a combination of the three approaches works best when measuring growth in real per capita GDP. The findings also indicate that some of the same variables, combined with AIDS infection rates, are beneficial in modeling the growth in human development.

I. Introduction

This paper looks at long-term growth in Africa and what factors increase it, as measured by growth rates in real per capita GDP and an index of human development. Forty-eight sub-Saharan African countries were studied because the countries of northern Africa are often considered part of the Middle East and are different in many respects from sub-Saharan Africa (Collier & Gunning, 1999). The paper is organized in the following manner. Section II discusses previous research on economic growth across countries. Section III introduces and defines the dependent and independent variables tested in the cross-section regressions and discusses the expectations of how each independent variable will affect the dependent variable. Section IV discusses the ten models included in this paper, variables deemed important to economic growth, and methods employed to perform the cross-section regressions. Section V discusses limitations of the models. Section VI summarizes and concludes.

II. Background

Thirty-two African nations are poorer now than in 1980, contributing to sub-Saharan Africa being the lowest-income region in the world (Collier & Gunning, 1999). Many reasons have been given as to why this is true and this paper explores some of these reasons.

The Solow growth model demonstrates that saving, population growth, and technology impact the levels and growth rates of output over time (Mankiw, 2003). Higher rates of saving or investment yield faster growth rates temporarily, until the economy reaches a new steady state where capital per worker is constant (Mankiw, 2003). Higher rates of population growth yield slower economic growth temporarily, until the economy reaches a new steady state. Higher rates of saving or investment are related to higher levels of GDP per capita, and higher rates of population growth are related to lower levels of GDP per capita (Mankiw, 2003). Since an

increase in population growth decreases the steady-state level of capital per worker, output level per worker also decreases, leading to a lower level of per capita GDP (Mankiw, 2003).

Geographic reasons such as climate and high transport costs have also been given to explain Africa's slow economic growth (Collier & Gunning, 1999). Africa's unfavorable climate causes poor health, reduces life expectancy, slows development, reduces soil quality because of unreliable rainfall, and limits African agriculture (Collier & Gunning, 1999). This is not conducive to growth, especially since agriculture accounts for approximately one-fourth of GDP in Africa (Collier & Gunning, 1999). The low population density across much of Africa, which results from the semi-arid conditions, and the fact that much of the population is landlocked contributes to the high transport costs that limit trade (Collier & Gunning, 1999).

Ndulu and O'Connell (1999, p. 64) argue that "political freedoms enhance the environment for capital accumulation and growth." They also say that it is crucial that external donors allow the African people and leaders to make their own national agenda for democratic governments and growth (Ndulu & O'Connell).

Adult mortality rates are expected to rise due to AIDS, and the epidemic is expected to have enormous effects on the economy, "especially since infection rates appear to be higher among the more educated" (Collier and Gunning, 1999, p. 8). Schultz (1999) states that AIDS slows economic growth by decreasing worker productivity. Low levels of health and education are two important factors that contribute to low productivity and low levels of growth (Schultz, 1999). The low levels of health appear to be the part of human capital that has had the most negative effect on African development (Schultz, 1999). Another measure of human capital is literacy rates. When referring to literacy rates, Barro and Sala-I-Martin (1995, p. 431-432) report that "a large spread between male and female attainment is a good measure of backwardness."

Large disparities between male and female literacy rates are therefore expected to negatively impact growth.

III. Data

The dependent variables are the twenty-year growth rate in real per capita GDP in 1995 dollars and the seventeen-year growth rate in an index of human development, denoted YCAP2 and H8502, respectively. The time period for the measure of the total twenty-year growth in real per capita GDP is from 1980 to 2000, and this data was collected from the World Bank. Due to data availability, the time period for the total seventeen-year human development growth runs from 1985 to 2002, with this data coming from the Human Development Reports website. The human development index measures life expectancy, the adult literacy rate, combined gross enrollment ratios for primary, secondary, and tertiary schools, and GDP per capita in 1995 and current purchasing power parity in US dollars.

Three approaches are used to model the growth in real per capita GDP, including a production function/Solow model, an institutional model, and a geographic model. Elements of the three approaches are then combined in order to present the best possible model for explaining growth.

The production function approach includes variables that measure human capital, physical capital, and population growth. The Solow model approach is included as an extension of the production function approach. It includes variables that measure human capital, physical capital, population growth, and initial income. The institutional approach utilizes a newly developed freedom index for African countries. This takes into account the quality of the government and institutions. The geographic approach uses three indicators that measure the percent of the population within 100 kilometers of the coastline, the air distance to key markets,

and the percent of land in the tropical region. When regressing the growth in human development, a combination of the aforementioned variables as well as AIDS infection rates are used.

Many independent variables were tested including the twenty-year growth rate of physical capital per worker (KPW2) and human capital per worker (HPW2). The coefficient on the growth of physical capital per worker is expected to be positive because increases in physical capital shift the full employment level of output to the right, which is an increase in real GDP. The coefficient on the growth of human capital per worker is expected to be positive because as people become more educated and have higher levels of health, productivity should increase. The growth rates of physical and human capital per worker were calculated as the change in the log of the variables over the twenty-year period. The physical and human capital data were yearly data obtained from a working paper by Baier, Dwyer, and Tamua (2004). The average annual population growth rates (POPGR17) from 1980 to 1997 were obtained from Jones (2002). These average annual rates were then multiplied by seventeen in order to obtain a seventeen-year growth rate to correlate with the twenty-year growth rates in human and physical capital per worker. The coefficient on POPGR17 is expected to be negative because as the population increases, the capital stock is spread more thinly over more people.

Initial real per capita GDP in 1980 data (INYC80) was obtained from the World Bank. The coefficient on this variable is expected to be negative because, due to convergence, it is easier for countries with smaller amounts of initial GDP per capita to see large amounts of growth more quickly than countries with larger amounts of initial GDP per capita. Gross domestic investment as a share of real per capita GDP data (GDI_GDP), a measure of the rate of saving or investment, was obtained from the World Bank. The coefficient on this variable is

expected to be positive as higher rates of saving or investment yield higher growth rates during the transition to a new steady state.

An alternate measure of growth in human capital is the difference in male and female literacy rates in 1990 (DIFF90). These were calculated by subtracting the 1990 female literacy rate from the 1990 male literacy rate for each sub-Saharan African country. These literacy rates were obtained from the website of the United Nations International Children's Emergency Fund (UNICEF). The coefficient on DIFF90 is expected to be negative because large disparities between male and female literacy rates are believed to indicate more backwardness with respect to education, which should negatively impact economic growth.

A recently developed freedom index (FREE) that was created by the Democrat Union of Africa and obtained from their website was also used. It used the following as indicators of freedom: regular elections that are free and fair, levels of literacy, women's equality, freedom of association, freedom of the press, the extent of military involvement in politics, the extent of minority rights, decentralization of the government, and the separation of powers in the government. This index measures freedom levels in 2003. The coefficient on FREE is expected to be positive because more freedom is thought to increase investment and economic efficiency, thus increasing growth in real per capita GDP and human development.

There were also three geographic variables included that were obtained from a working paper by Gallup, Sachs, and Mellinger (1999). They were the percent of the population within one hundred kilometers of the coastline (COAST), the minimum air distance to key markets (AIRD), and the percent of land in the tropical regions (TROPICS). The coefficient on COAST is expected to be positive because trade costs less near the ocean since the transport fee for goods is reduced. The coefficient on AIRD is expected to be negative because as the distance to key markets increases, the cost of trade increases thereby reducing economic growth. The coefficient

on TROPICS is expected to be negative because tropical climates decrease the productivity of the labor force and have negative effects on life expectancy and soil conditions.

The percent of the adult population, ages 15 to 49, with AIDS was also tested. This variable was measured at the end of 1999 (A99). The year 1999 was chosen because it was the earliest year that comprehensive data on AIDS infection rates could be obtained. It was obtained from the Joint United Nations Programme on HIV/AIDS (UNAIDS) website. The coefficient on the AIDS variable is expected to be negative because as more adults contract AIDS the labor force and its productivity decrease, and spending on healthcare and orphan care increases. These factors each have negative effects on performance, whether it is economic or human development growth.

Summary statistics, including variable descriptions, means, and ranges, are provided in Table 1. The average twenty-year growth in real per capita GDP is 0.0489 percent, ranging from -0.516 to 1.458. This is because many of the sub-Saharan African countries experienced negative GDP growth during the time period studied, demonstrated by the fact that thirty-two countries were poorer in 1999 than in 1980 (Collier & Gunning, 1999). The average seventeen-year growth in human development is 0.087, with a range of -0.219 to 0.455. The average twenty-year growth in physical capital per worker is 0.1091, ranging from -1.134 to 2.109. The average gross domestic investment share of GDP per capita is 0.2008, with a range of 0.0972 to 0.3273. The average twenty-year growth in human capital per worker is 0.219, ranging from 0.096 to 0.498. The average difference in male and female literacy rates is 0.1918, with a range of -0.25 to 0.33 points difference in literacy. A positive difference indicates that male literacy rates are higher than female literacy rates, while a negative difference indicates that female literacy rates are higher than male literacy rates. There are only two countries, Botswana and Lesotho, that had higher female literacy rates in 1990 than male literacy rates. The average

seventeen-year population growth from 1980 to 1997 is 0.4534, ranging from 0.170 to 0.612. The average initial real per capita GDP is $915.24, with a range of $117.17 to $5158.87. The average score on the 2003 freedom index is 57.7, ranging from 16 to 98. The average percent of land within the tropics region is 0.9239, with a range of 0 to 1. The average percent of the population within 100 kilometers of the coastline is 0.2447, ranging from 0 to 1. The average minimum air distance to key markets in 1000s of kilometers is 6265.9, with a range of 4180 to 9590. The average percent of the adult population with AIDS is 0.142, ranging from 0.0008 to 0.358.

IV. The Model

Cross-section data on the forty-eight sub-Saharan African countries were collected, although not all countries appear in each model because of missing data. White's heteroskedasticity-consistent standard errors and covariance were used in each regression. Ten models are reported in this paper. The first nine models presented are models that regress the growth in real per capita GDP. Models 1 and 2 use the production function approach, and Models 3, 4, and 5 employ the Solow model approach. Model 6 utilizes the institutional approach. Model 7 tests the geographic approach. Models 8 and 9 use a combination of the three approaches to model real per capita GDP growth. Finally, Model 10 uses a combination of variables, as well as the AIDS variable, to explain the growth in human development. All models are reported in Table 2.

Model 1 is a basic production function that only includes the twenty-year growth rates in physical capital per worker (KPW2) and human capital per worker (HPW2) as independent variables. This model explains slightly over 11 percent of the variation in growth rates with an adjusted R-squared value of 0.1110. KPW2 is significant at the 10 percent level and HPW2 is

almost significant with a p-value of 0.1461. As expected, the sign on the coefficient of KPW2 is positive because as growth in physical capital increases, growth in real per capita GDP should increase as well. The coefficient on KPW2 is 0.289, which indicates that a 10 percentage point increase in KPW2 causes the twenty-year growth rate in real per capita GDP to increase by approximately 2.8 percentage points.

Model 2 is also a production function, but it adds population growth over the twenty-year period (POPGR17) to the variables in Model 1. This addition is found to greatly improve the results, with the adjusted R-squared value increasing to almost 36 percent. POPGR17 is significant at the 5 percent level, HPW2 is significant at the 10 percent level, and KPW2 is almost significant at the 10 percent level with a p-value of 0.1025. The coefficient on HPW2 is positive as expected, since increases in the growth of human capital per worker should increase growth in YCAP2 as well. The results indicate that a 10 percentage point increase in HPW2 results in a 15.5 percentage point increase in the growth rate of real per capita GDP. The coefficient on POPGR17 is negative as expected, with a 10 percentage point increase resulting in a 24 percentage point decrease in the twenty-year growth rate of real per capita GDP.

Model 3 uses the Solow approach and includes the initial real per capita GDP in 1980 (INYC80), the average gross domestic investment share of real per capita GDP (GDI_GDP), and POPGR17. While GDI_GDP and POPGR17 are significant at the 10 percent level, INYC80 is not significant. The coefficient on GDI_GDP is positive as expected, indicating that a 10 percentage point increase in the ratio of GDI to real per capita GDP yields an increase in the twenty-year growth rate of real per capita GDP of slightly more than 0.27 percentage points. The coefficient on POPGR17 is negative as expected, indicating that a 10 percentage point increase in population growth over the seventeen-year period results in an 18.35 percentage point

decrease in twenty-year real per capita GDP growth. This model explains slightly over 27 percent of the cross-country variation in real per capita GDP growth.

Model 4 adds the growth in human capital per worker over the twenty-year period (HPW2) to Model 3. POPGR17 is highly significant at the 1 percent level with a negative coefficient, as expected. The coefficient on POPGR17 is -2.64 indicating that a 10 percentage point increase in population growth over the seventeen-year period results in a 26.4 percentage point decrease in twenty-year growth of real per capita GDP. GDI_GDP is slightly insignificant with a p-value of 0.1177, and INYC80 and HPW2 are insignificant with p-values of 0.1314 and 0.1617, respectively. This addition of HPW2 does increase the adjusted R-squared value from 0.2730 in Model 3 to 0.3334 in Model 4.

Model 5 is similar to Model 4, but it substitutes the difference in male and female literacy rates in 1990 (DIFF90) for HPW2. This alternate measure of human capital works well in this Solow-based model. While INYC80 remains insignificant and POPGR17 remains highly significant at the 1 percent level, GDI_GDP becomes significant at the 5 percent level. Results indicate that a 10 percentage point increase in GDI_GDP will result in a 0.257 percentage point increase in twenty-year growth in real per capita GDP. The coefficient on POPGR17 is negative as expected, and the coefficient on GDI_GDP is positive as expected. DIFF90 is also significant at the 5 percent level, and its coefficient is negative as expected. The coefficient on DIFF90 is -2.07, indicating that a 10 percentage point increase in the difference between male and female literacy rates will result in a 20.7 percentage point decrease in twenty-year real per capita GDP growth. This is in accordance with expected results because a large disparity between male and female literacy rates indicates "backwardness" with respect to educational achievement (Barro & Sala-I-Martin, 1995, p. 432). Countries with such backwardness will tend to have slower growth

rates in real per capita GDP. This model has a higher adjusted R-squared than Model 4, explaining almost 43 percent of the variation in growth in real per capita GDP.

The fact that INYC80 is not significant in any of the three Solow models presented indicates that there is no convergence in sub-Saharan African countries. This is probably due to the fact that most of these countries have low levels of initial income. The concept of convergence is that countries that are initially poor will grow faster than those that are initially rich. Since there are no initially rich countries, these countries will not display convergence.

Model 6 is an institutional model, as it only includes the freedom variable described earlier. FREE is not significant with a p-value of 0.1854. This model only explains slightly more than 4 percent of the variation in growth rates of real per capita GDP with an adjusted R-squared value of 0.0425.

Model 7 is a geographic model that includes the three previously discussed geographic variables to measure economic growth. None of the three variables prove to be significant in this model, but AIRD is almost significant with a p-value of 0.1503. This geographic model explains over 7 percent of the variation in growth rates with an adjusted R-squared value of 0.0754. TROPICS has a p-value of 0.6360 and COAST has a p-value of 0.4604.

Models 8 and 9 combine the production function, institutional, and geographic approaches. These models suggest that a combination of the three approaches produces the best results when modeling real per capita growth in GDP across countries. Model 8 includes POPGR17, KPW2, HPW2, FREE, and TROPICS. POPGR17 is significant at the 1 percent level, HPW2 and TROPICS are significant at the 5 percent level, FREE is significant at the 10 percent level, and KPW2 is almost significant at the 10 percent level with a p-value of 0.1126. This model has an adjusted R-squared value of 0.4154. The coefficient on POPGR17 is negative, as expected, meaning that increased population growth leads to decreased growth in

real per capita GDP. It indicates that a 10 percentage point increase in seventeen-year population growth yields almost a 24.9 percentage point decrease in twenty-year real per capita GDP. The coefficients on both HPW2 and KPW2 are positive, meaning that growth in human and physical capital lead to higher levels of growth in real per capita GDP. The coefficient on HPW2 indicates that a 10 percentage point increase in HPW2 results in a 19.7 percentage point increase in the twenty-year growth of real per capita GDP. The coefficient on FREE is also positive, which again is a measure of the institutional quality of the country, indicating that countries with higher levels of institutional freedom tend to see more growth in real per capita GDP over the long run. Its coefficient indicates that a 10 point increase in governmental and institutional freedom results in slightly over 6 percentage point increase in real per capita GDP. The coefficient on TROPICS is positive, which is not what was expected, and may indicate that although TROPICS has a negative impact on human capital due to increased spread of disease and decreased worker productivity, it has positive impacts on real per capita GDP through increased amounts of agriculture. Since most of the sub-Saharan African countries have a large portion or are completely in the tropics region, they may have adapted their economies to the tropical climate. Results indicate that a 10 percentage point increase in the land area in the tropics region will result in a 7.1 percentage point increase in twenty-year real per capita GDP growth. Another possible explanation for this positive coefficient is that this result may be unreliable since almost of all the countries are either completely in the tropics region or mostly in the tropics region.

Model 9 includes POPGR17, GDI_GDP, DIFF90, FREE, and TROPICS. This model used GDI_GDP, which is average gross domestic investment as a share of real per capita GDP, as an alternate measure of KPW2, the growth rate of physical capital per worker. Likewise, DIFF90, the difference between the 1990 male and female literacy rates, is substituted for

HPW2, the growth rate in human capital per worker. Each variable except FREE is significant in this model, and it has an adjusted R-squared value of 0.5204. FREE is almost significant, with a p-value of 0.1137. POPGR17 and TROPICS are significant at the 1 percent level, DIFF90 is significant at the 5 percent level, and GDI_GDP is significant at the 10 percent level. The coefficient on POPGR17 is negative as expected. The impacts of increases in POPGR17 and TROPICS are similar to those in Model 8, while TROPICS does have a somewhat stronger effect on real per capita GDP growth in this model than in Model 8. The coefficient on GDI_GDP is positive as expected, and the coefficient on DIFF90 is negative as expected. An increase of 10 percentage points in the average gross domestic investment share of real per capita GDP, GDI_GDP, results in an increase of almost 0.24 percentage points in twenty-year real per capita GDP growth. The negative coefficient on DIFF90 can be explained in the following way: If there is equality between male and female literacy rates, it will not hurt growth, but if male literacy rates are much higher than female, they will adversely affect real per capita GDP growth. In the sub-Saharan African countries studied, only two countries had higher rates of female literacy than male literacy. In many countries, there was a sizeable disparity between the two, while there were some countries with almost equal literacy rates between the genders. This can be interpreted as a signal to bring female literacy rates up to equal levels with male literacy rates to increase growth rates. The coefficient suggests that a 10 percentage point increase in the disparity between male and female literacy rates results in an almost 25.9 percentage point increase in twenty-year real per capita GDP growth. The coefficient on TROPICS is positive again, as in Model 8, which was not expected but perhaps can follow the same explanation about GDP gains due to agriculture and its possible unreliability due to the lack of variation presented in Model 6.

Model 10 is the only model included that has H8502, the growth in human development, as the dependent variable. It uses some of the same variables that were found to be significant in the models with real per capita GDP as the dependent variable. This model includes INYC80, POPGR17, GDI_GDP, TROPICS, and AIDS99 as the independent variables. INYC80, POPGR17, TROPICS, and AIDS99 are each significant at the 1 percent level, and GDI_GDP is significant at the 5 percent level. The coefficients on INYC80, POPGR17, TROPICS, and AIDS99 are negative as expected, and the coefficient on GDI_GDP is positive as expected. An increase in the initial income level of $1,000 would decrease the seventeen-year growth rate in human development by 18.4 percentage points. Results indicate that a 10 percentage point increase in the seventeen-year population growth rate will yield a 4.7 percentage point decrease in the growth rate of seventeen-year human development. A ten percentage point increase in the gross domestic investment share of real per capita GDP will result in a .069 percentage point increase in seventeen-year human development growth. Higher levels of population growth negatively affect long-term human development growth, while higher levels of the gross domestic investment share of real per capita GDP positively affect long-term human development growth. A tropical climate accelerates the spread of disease, and the results indicate that a 10 percentage point increase in TROPICS results in a 7.7 percentage point decrease in seventeen-year growth in human development. AIDS increases mortality rates and decreases life expectancy, and the coefficient on AIDS99 indicates that a 10.6 percentage point increase in the amount of adults infected with AIDS yields a percentage point decrease in seventeen-year human development growth. This model explains almost 64 percent of the variation in growth in human development with an adjusted R-squared value of 0.6360.

V. Limitations

Missing data is one significant limitation of the ten models presented because countries were only included if there was data for each variable in the regression. Thirty-seven countries were included in Model 6, thirty-four in Models 1, 3, and 7, thirty-three in Models 2, 5 and 8, thirty-one in Models 4 and 9, and twenty-eight in Model 10. The time periods were not always a complete reflection of the entire twenty-year period, as in the case of POPGR17 which ran from 1980 to 1997. AIDS data was only found for the latter part of the time periods for a large number of countries. Another limitation is that twenty-year growth rates and average growth rates were included if data on at least five years in each ten year period, from 1980 to 1990 and 1990 to 2000, were available. This increased the number of countries included in the models but did not provide the most accurate measure. There may be omitted variable bias, which could in part be eliminated using a panel regression. The use of panel data would eliminate unobserved fixed effects that do not vary over time. Another limitation is that it is hard to accurately measure levels of health and education for many reasons, including the fact that people may intentionally or unintentionally report inaccurate measures, which leads to biased coefficient estimates (Schultz, 1999). African countries also "appear to have more ethnic diversity than other poor nations of the world, which may make it harder to develop an interconnected economy" (Collier & Gunning, 1999, p. 6). But ethnic diversity's effects on growth have only been found to be negative in the presence of undemocratic governments; unfortunately, most African governments are undemocratic (Collier & Gunning, 1999). This is a limitation because no variables are included to account for ethnic diversity in sub-Saharan African countries. There also may have been correlation between certain variables, such as the AIDS variable or FREE variable with the human development indices. This is because the FREE variable included literacy rates as one of ten components. The human development measures included real per

capita GDP and purchasing power in 1995 among other variables, which would have been somewhat correlated with the initial income variable in Model 10.

VI. Conclusion

POPGR17 was significant in all of the models, and KPW2 or GDI_GDP, HPW2 or DIFF90, and TROPICS were significant or almost significant in most of the models of twenty-year growth in real per capita GDP. FREE was also significant in one of the two models and almost significant in the other one when a combination of all three approaches was used. The coefficients on these variables had their expected signs except for the coefficient on TROPICS. Again, the positive coefficient on TROPICS could be explained by the fact that approximately 25 percent of the GDP in these countries comes from agriculture (Collier & Gunning, 1999). These countries may have adapted their economies so that being in the tropical regions is economically beneficial, especially when it comes to agricultural gains. The TROPICS result may also be viewed as unreliable because there is not much variation in the TROPICS variable. One variable that was thought to have been highly significant in modeling both long-term real per capita GDP and human development growth was AIDS99. Although it was significant in regressing the seventeen-year growth in human development, it was not significant in regressing the twenty-year growth in real per capita GDP. FREE was another variable that was thought to be significant in modeling both measures of growth, but it was only significant when modeling real per capita GDP growth over the twenty-year period. One interesting result is the fact that POPGR17, GDI_GDP, and TROPICS were significant when using both measures of growth as the dependent variable. Another interesting result is that countries that have a higher percentage of literate males compared to females tend to have lower amounts of twenty-year real per capita GDP growth. This result is important in that it calls for more equality among male and female

literacy rates. The difference between male and female literacy rates might also be an indicator of civil freedom. A larger difference between the literacy rates indicates less civil freedom, which negatively affects long-term real per capita GDP growth. Although FREE and the geographical variables were not significant when using the institutional approach and the geographic approach separately in modeling twenty-year real per capita GDP growth, FREE and TROPICS became significant and helpful in explaining variation when used in combination with the production function/Solow model approach. From these results, it can be concluded that a combination of the three approaches is the best way to model long-term growth in real per capita GDP and human development in sub-Saharan African countries.

Table 1. Variable Descriptions, Means, and Ranges

Variable	Description	Mean
YCAP2	*Twenty-year growth rate in real per capita GDP, 1980-2000*	0.0489
H8502	*Growth in human development, 1985-2002*	0.0870
KPW2	*Twenty-year growth rate in physical capital per worker, 1980-2000*	0.1091
GDI_GDP	*Average gross domestic investment share of GDP per capita, 1980-2000*	0.2008
HPW2	*Twenty-year growth rate in human capital per worker, 1980-2000*	0.2190
DIFF90	*Difference in male and female literacy rates, 1990*	19.182
POPGR17	*Seventeen-year population growth, 1980-1997*	0.4534
INYC80	*Initial real per capita GDP in 1995 dollars, 1980*	915.24
FREE	*Freedom index, 2003*	57.708
TROPICS	*Percent of land in the tropics region*	0.9239
COAST	*Percent of population within 100 km of the coastline*	0.2447
AIRD	*Minimum air distance to key markets in 1000s of km*	6265.9
AIDS99	*Percent of adult population, age 15-49, with AIDS, 1999*	0.1420

Table 2. Results

Results of Regressions of 20 Year Real per Capita GDP Growth (YCAP2)

Regressor	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**
20 yr physical capital per worker growth (KPW2)	0.289* (0.098)	0.262 (0.103)			
20 yr human capital per worker growth (HPW2)	1.185 (0.146)	1.551* (0.095)		1.131 (0.167)	
17 yr population growth (POPGR17)		-2.407** (0.0270)	-1.835* (0.076)	-2.644*** (0.010)	-2.359*** (0.006)
Initial real per capita GDP (INYC80)			-3.18E-05 (0.313)	-5.10E-05 (0.131)	-6.74E-05 (0.226)
Avg GDI share of GDP per capita (GDI_GDP)			0.027* (0.078)	0.023 (0.118)	0.026** (0.048)
Difference in male and female lit rates (DIFF90)					-2.069** (0.036)
Intercept	-0.255 (0.118)	0.804 (0.133)	0.379 (0.517)	0.602 (0.291)	1.076** (0.018)
Summary Statistics					
Adjusted R-squared	0.111	0.358	0.273	0.333	0.429
n	34	33	34	31	33

1% (***), 5% (**), and 10% (*) significance levels are denoted as such.
P-values are in parentheses under the coefficients.

Table 2 (cont'd). Results

Results of Regressions of 20 Year Real per Capita GDP Growth (YCAP2)		
Regressor	**(6)**	**(7)**
Freedom index (FREE)	0.0054 (0.185)	
% of land area w/in tropics (TROPICS)		0.201 (0.636)
% of pop w/in 100 km of coastline (COAST)		0.263 (0.460)
Minimum air distance to key mkts (AIRD)		9.52E-05 (0.150)
Intercept	-0.279 (0.187)	-0.809 (0.256)
Summary Statistics		
Adjusted R-squared	0.043	0.075
n	37	34

1% (***), 5% (**), and 10% (*) significance levels are denoted as such.
P-values are in parentheses under the coefficients.

Table 2 (cont'd). Results

Results of Regressions of 20 Year Real Per Capita GDP Growth (YCAP2)		
Regressor	**(8)**	**(9)**
17 yr growth of population (POPGR17)	-2.490*** (0.009)	-2.505*** (0.000)
20 yr growth of physical capital (KPW2)	0.272 (0.113)	
20 yr growth of human capital (HPW2)	1.977** (0.029)	
Freedom index, 2003 (FREE)	0.006* (0.086)	0.004 (0.114)
% of land area w/in tropics (TROPICS)	0.712** (0.012)	0.923*** (0.000)
Avg GDI share of real per capita GDP (GDI_GDP)		0.024* (0.051)
Difference in male and female lit rates (DIFF90)		-2.589** (0.016)
Intercept	-0.306 (0.575)	0.094 (0.833)
Summary Statistics		
Adjusted R-squared	0.415	0.520
n	33	31

1% (***), 5% (**), and 10% (*) significance levels are denoted as such.
P-values are in parentheses under coefficients.

Table 2 (cont'd). Results

Results of Regressions of 17 Year Human Development Growth (H8502)	
Regressor	**(10)**
Initial real per capita GDP (INYC80)	-0.00018*** (0.000)
17 yr growth of population (POPGR17)	-0.467*** (0.007)
Avg GDI share of real per capita GDP (GDI_GDP)	0.007** (0.049)
% of land w/in tropics (TROPICS)	-0.773*** (0.001)
% of adults with AIDS (AIDS99)	-1.062** (0.000)
Intercept	1.106*** (0.000)
Summary Statistics	
Adjusted R-squared	0.636
n	28

1% (***), 5% (**), and 10% (*) significance levels are denoted as such.
P-values are in parentheses under coefficients.

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