

Growth creation and growth diversion in contiguous Sub-Saharan African countries

Ndem Tazifor and Carl E. Enomoto
New Mexico State University

Abstract

Several papers have analyzed how growth in neighboring countries can affect growth in individual Sub-Saharan African Countries. Some authors have suggested that a country is either not affected or negatively affected by the growth of surrounding countries, while others have found large, positive, and significant growth spillovers. Using lagged values of the average growth of contiguous countries, this study finds small, positive, and significant effects of growth in neighboring countries. Thus coordination of efforts and joint projects and investments can increase growth to several nearby African nations, even though the growth spillover effects are not large.

Introduction

A call for African unity was made by leaders, politicians, and business professionals, at the sixteenth session of the African Union (AU) held in Addis Ababa, Ethiopia from January 24 to 31, 2011 (Smith, 2011). There is a renewed and growing interest towards economic integration amongst African nations. Smith (2011, p. 22) stated, “The forum called for a new urgency on the part of governments to establish a single market for Africa, break down trade barriers, build new transport routes and press forward with regional power and water projects. It wants national leaders to urgently establish a pan-African stock exchange and mobilize reserves in Africa’s central banks...to invest in infrastructure projects.” Many believe that the separation of Africa into 53 countries has held back regional economic development and that the establishment of a unified Africa is paramount to higher and sustained growth. There already exist several Regional Economic Communities (RECs) in Africa such as the AMU (Arab Maghreb Union), COMESA (Common Market for East and Southern

Africa), ECOWAS (Economic Community of West Africa States), SADC (Southern African Development Community), and others (Smith, 2011, p. 23). While there are many benefits to establishing regional integration arrangements in Africa (Plazolo, 2002), some may have been formed as a matter of politics rather than economics. Furthermore, some countries belong to more than one economic community with different goals and agendas.

There are indeed, many benefits a nation receives from being close to rapidly growing neighbors. It has an expanding market for its exports and capital may be drawn to the region with greater access to financial markets for everyone. More jobs may be created in the region and a more developed infrastructure may be available. On the other hand, having rapidly growing neighboring countries can be a detriment. Capital flight and brain drain are two of the problems that may result in lower growth for a country with high growth neighbors. Thus it is an empirical issue as to how a nation's growth is affected by growth of contiguous countries. If, however, growth in surrounding nations is complementary to growth in a nation, then there is an even greater need for cooperation and unity among nearby countries. Nations will have an added incentive to work together to get projects approved in their region even if it is not in their own country. Arora and Vamvakidis (2005) referred to these gains inferred on a country by its neighbors as "spillover effects." They showed that growth in South Africa was driving growth in the other Sub-Saharan African countries even though Granger causality tests were inconclusive in determining the direction of causality. The authors also showed that growth in average per capita GDP in the rest of Africa did not significantly affect growth in individual African nations, except at the 10% level. The purpose of this paper is to determine if higher growth in contiguous Sub-Saharan African countries is growth creating or growth diverting for individual countries. Thus this study differs from that of Arora and Vamvakidis in that the focus is not on South Africa as the "engine of growth" for Sub-Saharan Africa and it is not growth in the rest of Africa that affects growth in a nation, but it is direct growth in contiguous African countries that drives growth in Sub-Saharan African countries. If it is found that growth in surrounding nations is

complementary to a nation's growth, then stronger arguments can be made for regional integration arrangements wherein regional projects are promoted.

The outline of this paper is as follows. In the next section, a brief review of the literature on regional growth in Africa will be presented. A model of endogenous growth will then be developed that takes growth in contiguous countries directly into account. The following section will describe the data and methodology used to estimate the model of endogenous growth and the final section will contain a discussion and conclusions.

Regional Growth in Africa

Ndulu, Kritzinger-van Niekerk, and Reinikka (2005) stated that in the past, policy makers had focused on health issues and education as primary growth strategies for African nations. The authors also stressed the importance of infrastructure and regional integration as new key ingredients for growth. One of the benefits of regional integration mentioned was that a joint effort could be applied to eradicate disease whereas a single nation might be incapable of stopping a disease that knows no borders. The authors also stated (p.116), "One area has to do with regional commons, that is, cooperation in the management of shared natural resources. There are initiatives like the Nile Basin or the Great Lakes, where countries come together to manage water shed in international rivers to everybody's benefit." Regional infrastructure projects that could reduce costs to all nations involved were also discussed including the "West Africa Power Market Development Project...(in which) Nigeria and Cote d'Ivoire could reduce their power generation costs..., the gas pipeline project between Mozambique and South Africa, the Nile Basin energy and conservation projects, and the planned West African Gas Pipeline project. Examples of investment coordination included the Southern Africa power grid sharing and roads program under the East African Community "(p. 117). The authors pointed out, however, that the current set of regional organizations may work against the effectiveness of regional integration.

Abuka (2005, p. 125) stated the following about regional integration in Africa, "The nature of regionalism in Africa is that many countries belong to more than one regional grouping, with the Democratic Republic of the Congo holding three

memberships. Multiple membership is only beneficial if the RIAs (regional integration arrangements) are compatible, which is not the case...Indeed, overlapping memberships in the different regional groupings—and hence overlapping commitments—have resulted in duplication of effort and occasionally inconsistent aims in African regional integration.”

The International Food Policy Research Institute (2005) stated that many of the smaller African nations would see gains from coordination and the development of regional institutions. Because of their lack of infrastructure, lack of access to markets and methods of financing projects, and lack of human capital, they could benefit from coordinated investment activities with other African nations. The International Food Policy Research Institute (2005, p.3) has further argued that improvement in transportation would have significant spillover effects. “For instance, Mozambique’s high transport costs also affect landlocked Malawi, which transports a majority of its exports and imports through its coastal neighbor. As a result, improving the productivity of Mozambique’s transport sector by 50 percent would generate a 16 percent increase in Mozambique’s agricultural exports, as well as a seven percent increase in Malawi’s agricultural exports.”

Abdulai, Diao, and Johnson (2005) developed a growth model incorporating regional integration. They introduced a variable, Z , that represented a regional public good. The integrated regional economy could use Z with growth spillover effects. Using a simulation model, the authors found that technological innovation starting in Kenya, Uganda, and Tanzania, in different commodities such as coffee, vegetables, and beef, resulted in significant spillover benefits to the region.

Easterly and Levine (1998) examined the effects of growth in neighboring countries on growth in individual countries in Sub-Saharan Africa. They found a large and positive significant effect. For every 1% increase in the average growth of neighboring countries, growth in individual countries increased by 0.55%.

In the next section, a growth model will be developed that takes into account both growth creation and growth diversion from contiguous countries.

An Endogenous Growth Model for Contiguous Countries

The production function for a given nation is represented by the following equation.

$$(1) \quad y = k^{1-\alpha} (e \cdot l)^\alpha,$$

where y is output, k is capital, l is the size of the physical labor force, and e is a parameter representing knowledge or the effectiveness of labor (Romer, 2012, p. 10). The term $e \cdot l$ represents units of effective labor. Thus a doubling of e when l is held constant, results in a doubling of the effective amount of labor. A constant-returns-to scale Cobb-Douglas technology is assumed where $0 < \alpha < 1$. This type of production technology was used by Romer (1986), Romer (1990), Lucas (1988), Barro (1990), and Aghion and Howitt (1992).

Growth in surrounding countries can have different effects on an individual nation. (1) It can increase the productivity or effectiveness of labor in a nation by increasing the access or availability of financial capital, by having a more developed infrastructure available, and by introducing new technology to the region. (2) It can lead to decreases in capital accumulation over time through capital flight whereby capital leaves the nation for the growing contiguous nations. It can also lead to “brain drain” where educated workers move to the high-growing contiguous countries. Under the first assumption that growth in surrounding countries increases the productivity and effectiveness of labor in a nation, the effectiveness of labor, e , can be represented as $e = \gamma \cdot g_c$, where $\gamma > 0$ and g_c is the average growth rate in the contiguous nations. The higher is γ or the higher is the average growth in contiguous countries, the greater is the effectiveness of labor in the individual nation. With the simplifying assumption that the physical labor force, l , is constant and equal to one, the production function in (1) becomes:

$$(2) \quad y = k^{1-\alpha} (\gamma g_c)^\alpha.$$

Assuming a constant saving rate, S , and a constant depreciation rate, δ , the change in the nation’s capital stock is given as:

$$(3) \quad \dot{k} = sy - \delta k,$$

where \dot{k} represents dk/dt , the change in capital per unit change in time, sY represents the fraction of output or national income that is saved and invested, and δk represents depreciation of capital. Substituting (2) into (3) yields:

$$(4) \quad \dot{k} = sk^{1-\alpha}(\gamma g_c)^\alpha - \delta k.$$

Dividing both sides of (4) by k , gives the following result:

$$(5) \quad \frac{\dot{k}}{k} = \frac{s}{k^\alpha}(\gamma g_c)^\alpha - \delta.$$

The expression in (5) represents the growth rate of capital, g_k which is positively related to the average growth rate in surrounding countries. Furthermore, from equation (2), the growth rate of y , g_y , depends on the growth rate of capital and thus the growth rate of y will also depend on the average growth rate in contiguous countries as expressed in equation (6).

$$(6) \quad g_y = f(g_c),$$

where $f' > 0$. This is the case of growth creation or complementary growth wherein growth in surrounding countries leads to growth in an individual country.

In the second case, growth in contiguous countries draws capital away from a nation (capital flight) and thus lowers capital accumulation over time in a country as given in the following equation.

$$(7) \quad \dot{k} = sy - \delta k - \beta \cdot g_c,$$

where $\beta > 0$ and $\beta \cdot g_c$ represents the reduction in capital accumulation in a nation due to a higher value of β or a higher average growth rate in surrounding countries. Dividing both sides of (7) by k and using equation (1) with l again set to 1, yields the result in (8).

$$(8) \quad \frac{\dot{k}}{k} = \frac{se^\alpha}{k^\alpha} - \delta - \frac{\beta g_c}{k}.$$

The expression in (8) represents the new growth rate of capital which is negatively related to the average growth rate in contiguous countries. Since the growth rate of y depends on the growth rate of capital from equation (1), the growth rate of y again depends on the average growth rate in contiguous countries as illustrated in the following equation.

$$(9) \quad g_y = h(g_c),$$

where $h' < 0$. This is the case of growth diversion wherein higher growth in surrounding countries diverts or reduces growth in the individual country.

In the next section the data and methodology for estimating the growth model that has been developed for contiguous countries will be described.

Data and Methodology

From the endogenous growth model for contiguous countries, growth in an individual country depends on the average growth in contiguous countries. There are also several other factors that researchers have identified that contribute to a country's growth including the initial level of GDP, life expectancy, the investment-to-GDP ratio, amount of schooling, and the degree of ethno-linguistic diversity (Easterly and Levine, 1997). Thus the growth equation to be estimated for individual Sub-Saharan African countries was specified as:

$$(10) \quad g_y = g_y(g_c, gdp, lifex, inv, educ, ethnic),$$

where g_y is the individual country's growth rate, g_c is the average growth rate in contiguous countries, gdp is the initial level of GDP, $lifex$ is life expectancy, inv is the investment-to-GDP ratio, $educ$ is the amount of schooling received, and $ethnic$ is a measure of the amount of ethno-linguistic diversity.

To estimate equation (10), data was collected for twenty five Sub-Saharan African countries (for which data on all variables was available) including: Benin,

Botswana, Cameroon, Central African Republic, Congo (Democratic Republic), Gambia, Ghana, Guinea-Bissau, Kenya, Lesotho, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sierra Leon, South Africa, Sudan, Swaziland, Togo, Uganda, Zambia, and Zimbabwe. Easterly and Levine (1997) used the average annual growth rate of per capita GDP over three ten year periods, the 1960s, the 1970s, and the 1980s, as their dependent variable for equation (10). Thus there were three observations for each country. Following their work, the dependent variable for each country in this study was measured as the average annual growth rate of per capita GDP over three ten-year periods: 1981 to 1990, 1991 to 2000, and 2001 to 2010, and country GDP figures were taken from the United Nations International Human Development Indicators. Thus there were three observations for each country and seventy five observations in the panel data set (25 countries and 3 (ten-year) time periods).

In equation (10), the first independent variable is the average growth rate in contiguous countries, represented by g_c . The problem of simultaneity could occur where growth in contiguous countries affects growth in an individual country and growth in the individual country affects growth in contiguous countries. Easterly and Levine (1998) used an instrumental variables approach to get around this problem. The instruments used were the right-hand side variables of the growth equation for the neighboring countries. This presents a problem, however, if growth in the individual country also affects the values of these variables for the neighboring countries. Thus we used the instrumental variable technique suggested by Barro (1997) where the instruments are lagged average growth rates in contiguous countries. For example, Botswana is surrounded by Namibia, South Africa, Zimbabwe, and Zambia. The average annual growth rate in per capita GDP was calculated for Namibia, South Africa, Zimbabwe, and Zambia from 1976 to 1980. The average of these figures was then used as the independent variable g_c , for equation (10) when the dependent variable was Botswana's average annual growth rate in per capita GDP from 1981 to 1990. Similarly, the average of the average annual growth rates of per capita GDP in Namibia, South Africa, Zimbabwe, and Zambia from 1986 to 1990 was used as the independent variable

Table 1
Average Annual Growth Rates in African Countries

Country	1976-80	1986-90	1996-00
Algeria	0.020304	-0.01327	0.011106
Angola	-0.00888	0.013183	0.035247
Benin	0.015435	-0.01952	0.016078
Botswana	0.063426	0.064467	0.01737
Burkina Faso	0.000195	-0.01565	0.053401
Burundi	-0.00222	0.010771	-0.0123
Cameroon	0.054212	-0.05265	0.018286
Cape Verde	0.041232	0.019011	0.040567
Central African Republic	-0.02397	-0.0264	0.012654
Chad	-0.05935	0.002251	-0.00624
Comoros	-0.01965	-0.00943	-0.01237
Congo	0.023319	-0.01329	-0.00989
Congo (Democratic Republic of the)	-0.0263	-0.03244	-0.04935
Côte d'Ivoire	-0.01476	-0.02399	-0.00424
Djibouti	-0.07011	-0.03346	-0.01751
Egypt	0.046488	0.025107	0.029903
Equatorial Guinea	-0.04165	-0.00338	0.334415
Eritrea	0.008431	0.00331	-0.03026
Ethiopia	-0.00457	0.011192	0.00581
Gabon	-0.06817	-0.00439	-0.0166
Gambia	0.002536	0.002461	0.012457
Ghana	0.00392	0.015024	0.016303
Guinea	0.008269	0.01022	0.01635
Guinea-Bissau	-0.03278	0.020418	-0.03817
Kenya	0.027202	0.015207	0.032271
Lesotho	0.059632	0.045614	0.004317
Liberia	-0.01149	-0.12736	0.409348
Libyan Arab Jamahiriya	0.022134	0.118474	0.011585
Madagascar	-0.00176	-0.00062	0.009398
Malawi	0.013303	-0.02096	0.00558
Mali	0.006576	0.003666	0.023438
Mauritania	-0.00422	-0.00451	0.046747

Table 1 continued
Average Annual Growth Rates in African Countries

Country	1976-80	1986-90	1996-00
Mauritius	-0.00809	0.052233	0.041864
Morocco	0.01807	0.011309	0.00069
Mozambique	0.010152	0.077031	0.051903
Namibia	-0.01296	-0.01695	0.009746
Niger	0.033257	-0.00862	-0.00652
Nigeria	-0.00274	0.028227	0.000709
Rwanda	0.037715	-0.02053	0.020283
Sao Tome and Principe	-0.00818	-0.00273	0.001257
Senegal	-0.0242	-0.00044	0.024128
Seychelles	0.039106	0.050888	0.047953
Sierra Leone	0.007919	0.01197	-0.04573
Somalia	-	-	-
South Africa	0.006105	-0.00187	0.008915
Sudan	-0.03456	-0.01146	0.030226
Swaziland	0.004646	0.055415	0.011793
Tanzania (United Republic of)	0.001065	0.00858	0.010606
Togo	0.029365	-0.00618	0.000398
Tunisia	0.029168	0.015597	0.033536
Uganda	-0.00365	0.017766	0.023776
Zambia	-0.02889	-0.0098	-0.00794
Zimbabwe	-0.00591	0.014044	-0.02039

when the dependent variable was Botswana's average annual growth rate in per capita GDP from 1991 to 2000. Thus the average growth rate in contiguous countries was measured five years before the average growth rate in the individual country. In this fashion, growth in contiguous countries drives growth (or reduces it) in the individual country and growth in the individual country does not drive growth in contiguous countries. The coefficient of g_c in equation (10) could be positive or negative depending on whether growth in contiguous countries creates growth in the individual

country or diverts it away from the individual country. Table 1 gives the average annual growth rate in per capita GDP for African countries over the periods, 1976 to 1980, 1986 to 1990, and 1996 to 2000. Table 2 lists the contiguous countries for the twenty five individual Sub-Saharan African countries used in this study and Table 3 contains the average annual growth rate of per capita GDP in the contiguous countries for each of the twenty five individual countries over the three five-year periods. The countries of Africa are shown in Figure 1.

Figure 1: Sub-Saharan Africa



Map Source: www.worldmap.org

Table 2
Contiguous Sub-Saharan African Countries

Country	Contiguous countries
Benin	Togo, Niger, Burkina Faso and Nigeria
Botswana	Namibia, South Africa, Zimbabwe, Zambia
Cameroon	Equatorial Guinea, Gabon, Congo, Chad, Nigeria, Central African Republic
Central African Republic	Congo, Chad, Congo (democratic republic), Sudan, Cameroon
Congo (Democratic Republic)	Congo, Angola, Zambia, Tanzania, Burundi, Uganda, Rwanda, Central African Republic, Sudan
Gambia	Senegal
Ghana	Cote d'Ivoire, Burkina Faso, Togo
Guinea-Bissau	Senegal, Guinea
Kenya	Uganda, Tanzania, Ethiopia, Somalia, Sudan
Lesotho	South Africa
Malawi	Tanzania, Mozambique, Zambia
Mali	Algeria, Niger, Burkina Faso, Cote d'Ivoire, Guinea, Senegal, Mauritania
Mauritius	Island country
Mozambique	Tanzania, Malawi, Zambia, Zimbabwe, Swaziland
Niger	Algeria, Libya, Chad, Nigeria, Benin, Burkina Faso, Mali
Rwanda	Congo (democratic republic), Burundi, Tanzania, Uganda
Senegal	Mauritania, Mali, Guinea, Guinea-Bissau, Gambia
Sierra Leone	Guinea, Liberia
South Africa	Lesotho, Namibia, Botswana, Zimbabwe, Mozambique, Swaziland
Sudan	Kenya, Ethiopia, Eritrea, Egypt, Libya, Chad, Central African Republic, Congo (democratic republic), Uganda
Swaziland	Mozambique, South Africa
Togo	Benin, Ghana, Burkina Faso
Uganda	Kenya, Tanzania, Rwanda, Congo (democratic republic), Sudan
Zambia	Congo (democratic republic), Angola, Namibia, Botswana, Zimbabwe, Mozambique, Malawi, Tanzania
Zimbabwe	Zambia, Botswana, South Africa, Mozambique, Namibia

Table 3: Average Annual Growth Rates of Contiguous Countries

Country	Year	Avg. Growth of Contiguous Countries
Benin	1976-1980	0.015019698
Benin	1986-1990	-0.000556071
Benin	1996-2000	0.011995968
Botswana	1976-1980	-0.010414027
Botswana	1986-1990	-0.00364295
Botswana	1996-2000	-0.002419767
Cameroon	1976-1980	-0.028759107
Cameroon	1986-1990	-0.009063779
Cameroon	1996-2000	-0.000521707
Central African Republic	1976-1980	-0.008535946
Central African Republic	1986-1990	-0.021519746
Central African Republic	1996-2000	-0.003391064
Congo (Dem. Rep. of the)	1976-1980	-0.004452937
Congo (Dem. Rep. of the)	1986-1990	-0.003465404
Congo (Dem. Rep. of the)	1996-2000	0.011407013
Gambia	1976-1980	-0.024201507
Gambia	1986-1990	-0.000435708
Gambia	1996-2000	0.024128493
Ghana	1976-1980	0.004934817
Ghana	1986-1990	-0.015274869
Ghana	1996-2000	0.016519758
Guinea-Bissau	1976-1980	-0.007966338
Guinea-Bissau	1986-1990	0.004892373
Guinea-Bissau	1996-2000	0.020239444
Kenya	1976-1980	-0.010430209
Kenya	1986-1990	0.00651955
Kenya	1996-2000	0.017604498
Lesotho	1976-1980	0.006104865
Lesotho	1986-1990	-0.001868445
Lesotho	1996-2000	0.00891469
Malawi	1976-1980	-0.005890956
Malawi	1986-1990	0.02526976
Malawi	1996-2000	0.018188091
Mali	1976-1980	0.002692773
Mali	1986-1990	-0.008037482

Table 3 continued: Average Annual Growth Rates of Contiguous Countries

Country	Year	Avg. Growth of Contiguous Countries
Mali	1996-2000	0.020138349
Mauritius	1976-1980	
Mauritius	1986-1990	
Mauritius	1996-2000	
Mozambique	1976-1980	-0.00315808
Mozambique	1986-1990	0.009454742
Mozambique	1996-2000	-7.19E-05
Niger	1976-1980	0.00036546
Niger	1986-1990	0.014882668
Niger	1996-2000	0.01572593
Rwanda	1976-1980	-0.00777644
Rwanda	1986-1990	0.001168374
Rwanda	1996-2000	-0.00681543
Senegal	1976-1980	-0.00392357
Senegal	1986-1990	0.006450234
Senegal	1996-2000	0.012165179
Sierra Leone	1976-1980	-0.00161223
Sierra Leone	1986-1990	-0.05857188
Sierra Leone	1996-2000	0.212849103
South Africa	1976-1980	0.019830777
South Africa	1986-1990	0.039937466
South Africa	1996-2000	0.012455634
Sudan	1976-1980	-0.00150909
Sudan	1986-1990	0.014939981
Sudan	1996-2000	0.003350899
Swaziland	1976-1980	0.008128645
Swaziland	1986-1990	0.037581031
Swaziland	1996-2000	0.030408731
Togo	1976-1980	0.006516943
Togo	1986-1990	-0.0067154
Togo	1996-2000	0.02859416
Uganda	1976-1980	0.001023819
Uganda	1986-1990	-0.008129227
Uganda	1996-2000	0.008808206
Zambia	1976-1980	0.004237238
Zambia	1986-1990	0.013368899
Zambia	1996-2000	0.007589028
Zimbabwe	1976-1980	0.007567301
Zimbabwe	1986-1990	0.022576437
Zimbabwe	1996-2000	0.015997671

The independent variable *gdp* is the initial level of GDP measured in log form. It is the value of GDP in 1980, 1990, and 2000, corresponding to each country's average annual growth rate over the three decades: 1981 to 1990, 1991 to 2000, and 2001 to 2010, respectively. The coefficient of *gdp* is expected to be negative, given the property of conditional convergence where a lower starting value of GDP is associated with a higher growth rate. That is, poor countries grow faster than rich countries if all other factors that affect their steady-states are held constant.

The variable *lifex* is life expectancy at birth measured in 1980, 1990, and 2000 (UNDESA—United Nations Department of Economic and Social Affairs, 2009d). The coefficient of this variable should be positive since greater life expectancy is an indicator of good health which leads to increased labor productivity and a higher growth rate.

The next variable *inv* is the investment-to-GDP ratio (World databank African Development Indicators). This variable is expected to be positively related to growth in per capita GDP since more investment leads to greater capital accumulation and a higher growth rate. The value of this variable was measured for each country in 1980, 1990, and 2000, for the three decades: 1981 to 1990, 1991 to 2000, and 2001 to 2010, respectively.

The variable *educ* is the average years of schooling in each country (World databank African Development Indicators). It was also measured for each country in 1980, 1990, and 2000, for the three 10-year periods for which the average annual growth rates were calculated for the individual countries. The coefficient of *educ* should be positive, since more education results in a more productive labor force and a higher growth rate.

As a result of the work of Easterly and Levine (1997), researchers have included the variable *ethnic* in growth equations for African countries. In the original work of Easterly and Levine, the variable *ethnic* measured the probability that two individuals drawn at random from a country were from different ethno-linguistic groups. The authors stated that Mauro (1995) used this variable as a proxy for corruption. Easterly and Levine found that a high degree of ethno-linguistic diversity led to poor public policies. It could lead to a struggle for power, bribery, corruption, and rent-seeking

behavior, all of which tend to lower growth in a country. The authors cited the examples of Kenya, with more than 40 different ethnic groups, and Ghana, where ethnic diversity has resulted in “growth-retarding policies.” The authors also stated (p. 1218), “Finally, in contrast to Ghana and Kenya, Botswana is an African success story with growth comparable to South Korea’s...it is noteworthy that Botswana has one of the most ethnically homogeneous populations in Africa and has adopted some of the best policies in Sub-Saharan Africa.”

Another measure of ethnic diversity for Africa has been developed by Posner (2004). By adjusting for new political groups and dropping old groups, he has also calculated decade values (1960s, 1970s, 1980s, and 1990s) for his measure of ethnic diversity for 42 African countries. In this study, we used his measure of ethnic diversity for the twenty five Sub-Saharan African countries in our sample. The coefficient of *ethnic* is expected to be negative, since a higher degree of ethno-linguistic diversity has been shown to be associated with corruption and poor growth policies.

Table 4
 Summary Sample Statistics

Variable	Mean	Standard Deviation
g_y	0.006565	0.022052
g_c	0.006964	0.028928
gdp	6.151787	0.963877
lifex	3.908898	0.13334
inv	19.63889	10.11944
educ	3.273736	1.529251
ethnic	0.375139	0.241766
D1990	0.333333	0.474713
D2000	0.333333	0.474713

g_y is the average annual growth rate in per capita GDP for individual countries over 3 ten-year periods: 1981-1990, 1991-2000, and 2001-2010. g_c is the average annual growth rate in per capita GDP for the contiguous countries over 5-year period: 1976-80, 1986-90, and 1996-2000. gdp is the log of initial GDP for 1980, 1990, and 2000. lifex is the log of life expectancy in 1980, 1990, and 2000. inv is the investment-to-GDP ratio in 1980, 1990, and 2000. educ is the average number of years of schooling in 1980, 1990, and 2000. ethnic is the degree of ethno-linguistic diversity in a nation for 1980s, 1990s, and 2000s. D1990 is 1 if the year is for the 1990s, 0 otherwise. D2000 is 1 if the year is for the 2000s, 0 otherwise.

Finally, two dummy variables, D1990 and D2000, were added to the growth equation to allow for changes in growth over time. D1990 was equal to 1 if the observation was for a country's growth in the 1990s and 0 otherwise. D2000 was equal to 1 if the observation was for a country's growth in the 2000s and 0 otherwise. Time dummy variables were also used by Easterly and Levine. A summary of all the variables used in this study and their descriptive statistics is contained in Table 4.

In the next section, the estimates of the coefficients of the growth model will be presented and interpreted, followed by a discussion and conclusions.

Findings

The growth equation for the Sub-Saharan African countries that was specified in the previous section was estimated using ordinary least-squares with fully robust standard errors to account for heteroscedasticity (among the cross-sectional units) and autocorrelation (across time for each country) in the panel data set. The results appear below.

$$(11) \quad g_{y_{it}} = -0.078 + 0.140(g_{c_{it}}) - 0.002(gdp_{it}) + 0.020(lifex_{it}) + \\
 \begin{matrix} (-2.326)^* & (4.403)^* & (-0.874) & (2.348)^* \end{matrix} \\
 0.001(inv_{it}) - 0.001(educ_{it}) - 0.007(ethnic_{it}) + \\
 \begin{matrix} (4.170)^* & (-0.421) & (-2.153)^* \end{matrix} \\
 0.005(D1900_{it}) + 0.016(D2000_{it}), \\
 \begin{matrix} (2.220)^* & (4.539)^* \end{matrix}$$

where t-statistics appear in parentheses and * represents a coefficient that is statistically significant at the 5% level. The adjusted R-squared was 0.484 and all coefficients were significant at the 5% level except those for the initial level of GDP and *educ*. The subscript *i* for each variable refers to the individual country and the subscript *t* refers to the time period (decade) being the 1980s, 1990s, or 2000s. The log of birth rates was also tried as an explanatory variable but was found to be insignificant at the 5% level and was therefore dropped from the growth equation.

The results indicate that every 1% increase in the average growth rate of per capital GDP in contiguous countries, growth in per capita GDP of a Sub-Saharan African

country increases by 0.14%. Growth in contiguous countries is complementary to growth in a country. The benefits, availability, and access to financial markets and near-by infrastructure and technology, outweigh the costs of being close to high-growth neighbors. For every additional year of life expectancy at birth, the average annual growth rate of per capita GDP in a country increases by 0.02% in Sub-Saharan Africa and for every 1% increase in the investment-to-GDP ratio, the average annual growth rate in a nation increases by 0.001%. Finally, the greater the degree of ethno-linguistic diversity in a nation, the lower is the average annual growth rate of per capita GDP in a Sub-Saharan African country.

Discussion and Conclusions

In this paper, an endogenous growth model was developed that took into account the two effects of growth in contiguous countries on a given country. 1) Growth in contiguous countries can increase growth in an individual country. 2) Growth in contiguous countries can divert growth away from an individual country. Using panel data for twenty five Sub-Saharan African countries over three separate decades, this study found the following. 1) Growth in contiguous countries drives growth in an individual country. 2) A greater life expectancy increases growth in Sub-Saharan African countries. 3) More investment leads to growth. 4) A greater degree of ethno-linguistic diversity leads to lower growth. Given that growth in contiguous countries is complementary to growth in an individual country, an argument can be made for regional integration in Sub-Saharan African countries. Coordination of efforts and joint projects such as the West Africa Power Market Development Project, the gas pipeline project between Mozambique and South Africa, the Nile Basin energy and conservation projects, the West African Gas Pipeline project and the Southern Africa power grid sharing and roads program under the East African Community, are just a few examples cited earlier that would benefit an entire region, not just the countries involved.

Does everyone agree that nations in Sub-Saharan Africa gain by forming coalitions with neighboring countries? Abuka (2005, p. 126) stated, "The benefits of regionalism are likely to depend on finding the best partner. The notion of "natural"

trading partner should be dropped and is no longer useful. The obvious tendency is for trade blocs to form around neighboring countries, including the desire to reduce trade costs by relaxing or abolishing boarder formalities and to facilitate collection of tax revenues. Most likely, this development will result into trade diversion rather than trade creation because of discriminatory or restricted liberalization.”

On the other hand, Easterly and Levine (1998) found a strong reason for regional integration with neighboring countries. For every 1% increase in the average growth of neighboring countries, growth in an individual country increases by 0.55%. Our study gives results that lie somewhere in between the ideas of Abuka and Easterly and Levine. First, we used different instruments for the independent variable, average growth in contiguous countries, than did Easterly and Levine (1998). Easterly and Levine used the right-hand-side variables of the growth equation for the contiguous countries and we used lagged values (over the previous five years) of the average growth in surrounding countries. Second, Easterly and Levine (1998) used data for the 1960s, 1970s, and 1980s. We used data for the 1980s, 1990s, and 2000s. Furthermore, Easterly and Levine (1997) found that ethno-linguistic diversity in Sub-Saharan Africa was a significant and important variable that explained cross-country differences in growth, yet they excluded this variable from the growth equation when examining the effect of growth in contiguous countries. By including an ethno-linguistic diversity variable in our growth equation, we found that growth in contiguous countries still had a significant and positive effect on growth in individual countries in Sub-Saharan Africa but the effect was now much smaller. Our results indicated that for every 1% increase in the average growth rate in per capita GDP in contiguous countries, growth in an individual Sub-Saharan African country increased by 0.14%. It is good to have high growth neighbors and regional integration and coordination of efforts and projects are useful. However, spillover effects from growth in surrounding countries cannot be counted on as the major driving force of growth for individual countries in Sub-Saharan Africa.

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