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Replicating 'Sources of Slow Growth in African Economies'

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Replicating 'Sources of Slow Growth in African Economies'*

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ABSTRACT

The most cited paper ever published by the Journal of African Economies is Jeffrey Sachs and Andrew Warners "Sources of Slow Growth in African Economies." The paper advises that despite decades of slow growth in Africa there should be considerable optimism regarding Africa's future; if it could have only managed policy and governance quality that equalled the average non-African developing economy its growth rate from 1965 to 1990 would have almost doubled. My attempt to purely replicate this conclusion fails. Adopting other developing country policies would have increased African growth, but by only 0.05 percentage points. Policy does have a strong influence on growth. Nevertheless, Africa grew more slowly than other developing countries not because of policy differences, which were in aggregate small, but because of its relatively unfavourable geography, changing demography and the poor health of its population. This change in finding now aligns the paper with the three other contemporaneous papers that investigated Africa's slow growth performance and find that poor policy was a minor factor.

JEL **codes: O11, O13, O55, Q32, Q33, B40**
Keywords: **Replication, Sachs and Warner, Growth, Sub-Saharan Africa**

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Introduction

Between 1965 and 1990, the 40 Sub-Saharan Africa (SSA) countries for which we have data grew at an average real annual per capita rate of 0.80%. If we exclude Botswana, which was the fifth fastest growing developing economy in the world over that period, the rate drops to 0.67%. The rest of the developing world, or at least the 48 countries for which we have data, grew at an average rate of 1.96% annually over this same period. Even if we exclude seven fastest-growing economies outside of Africa from this mix, the rest of the group grew at 1.30% annually.

Why did Africa grow so slowly? Was it unfortunate geography? Poor demographics? Poor government policies? Or was there some unaccountable factor unique to Africa, known as the Africa dummy? In a now classic 1997 paper published in the *Journal of African Economies* (JAE), Jeffrey Sachs and Andrew Warner (1997b) examine this question using a cross-sectional growth-regression methodology that was the mainstay of a suite of six of their papers investigating economic growth (Sachs and Warner 1997a, 1997b, 1997c, 1999a, 1999b, 2001). The JAE paper uses approximately the same cross-country regression model as the 1997a paper, but with an expanded data set that has been subsequently used in other growth analyses (the indices of trade openness, institutional quality, and geography have been especially used). Sachs and Warner (hereafter SW) come to the conclusion that poor policies, and especially closed trade policies, were more to blame for Africa's slow growth than unfavorable geography. The closed trade policies were in turn a reaction to Africa's colonial legacy. They conclude their paper by stating that "…even with its natural disadvantages, Africa could have grown at over 4% per year in per capita terms with appropriate policies" (p. 361). This is an astounding finding, not only for the present world that such growth conjures, but it immediately led to political science investigations as to why more appropriate growth policies were not followed by African leaders (e.g., Englebert 2000). It also suggests that multilateral institutional support for policy making and open market reforms may be as important for improving African growth as is aid to improve transportation infrastructure.

This SW paper is the most cited paper ever published in JAE, and by a wide margin.[1] It is prominently mentioned in two subsequent survey articles on Africa's growth (Collier and Gunning 1999a, 1999b), and, along with Bloom et al. (1998), Easterly and Levine (1998), and Temple (1998), is part of a respected quartet of papers on African growth that appeared at the time. SW's paper differentiates itself from the others by claiming that government policy and institutional quality are exogenous to growth via their effect on domestic savings rates and overall efficiency, and for its claims of a relatively large impact that policy and institutions have had on growth. An early version of the results was presented in the popular press (Sachs 1996), with a recommendation that aid to Africa be conditioned on reforms towards trade openness.

[1] As of 8/6/2012 it had 950 cites according to Google Scholar. The next most cited paper had 233 cites.

To my knowledge the SW paper has never been purely replicated. [2] I undertake this replication here. The need for, and the impediments against, replicating empirical economics research is nicely summarized in Anderson et al. (2008) and Tomek (1993). Davis (2012) provides the motivation for specifically replicating the Sachs and Warner series on growth. Replication of this paper is of interest in relation to the rest of the papers in the quartet because of its strong focus on African policy.

SW make four broad conclusions from their analysis:

1. Growth in Africa, and indeed in all countries, can be well explained when using the appropriate set of conditioning variables. There is no need for an African dummy or to control for neighborhood effects in Africa.

2. Aside from convergence effects related to initial income levels, government policy, and in particular policy with regard to a measure of trade openness, is the most important determinant of economic growth. The health of the population is the next most important determinant.

3. Had the average African country adopted the average trade policy, savings policy, and institutional quality levels of the seven fastest growing developing economies outside of Africa from 1965 to 1990, its real per capita growth rate would have risen from 0.80% to 4.3% per year.

4. Had the average African country adopted the average trade policy, savings policy, and institutional quality levels of the rest of the developing economies from 1965 to 1990, its real per capita growth rate would have risen from 0.80% to 1.4% per year. This effect is larger than the effect of unfavorable geography on Africa's growth.

The last conclusion is inconsistent with the results from Bloom et al. (1998), a contemporaneous paper that uses the same data set to find that had Africa adopted Latin America and the Caribbean's policy levels its growth would have been only 0.05 percentage points higher.[3] From this Bloom et al. conclude that it is geography, demography, and public health that caused Africa's poor relative growth performance, not policy.

While my replication finds that there are discrepancies in one of SW's reported regression results, the main discrepancies are in translating the regression results into quantitative assessments of the potential growth for the African economies in the data set under different counterfactuals. I am able to replicate conclusions 1 and 2. The

[2] See Hammermesh (2007) for a discussion of the different types of replication. Pure replication attempts to replicate results using the same data and model. Temple (1998) mentions testing the SW results for sample robustness and specification robustness as part of his investigation into African growth, which is statistical replication, but does not report the results in detail.

[3] They do not report the counterfactual of following the average policies of all other developing economies.

conclusion that Africa could have grown at 4.3% per year is not replicable; the estimated growth is downgraded to 4.0% in my replication. This is still a substantial policy boost and far larger than other estimates at the time.[4] The rate at which Africa could have grown had it followed average other developing country policies is only 0.85% in my replication, not 1.4%. As such, Africa's policies, while below par, were not why it lost substantial ground to other developing economies from 1965 to 1990. Geography, changing demography, and public health were the culprits, putting the replication results squarely in line with those of Bloom et al. (1998). This finding suggests that there is no particular African policy problem, and therefore no particular need for special political economy models related to Africa's policy choices.

My inability to replicate conclusions 3 and 4 causes me to rate the replication 1 out of 5 on the Glandon (2011) Replication Accuracy Rating System. A score of 1, "Serious Discrepancies," indicates that "an error in the analysis has probably led to incorrect conclusions" (p. 699).[5] In the remainder of the paper I review the data and empirics in each of the sections of the SW paper in order. The only section I do not review is Evidence on Growth and Reform in Africa, since there are no computations in that section.

Data Used to Explain Growth

The data are currently available at http://www.cid.harvard.edu/ciddata/ciddata.html. There is a readme text file, an Excel file, a DO file with the regressions in Table 2 and Appendix Table A1 coded in STATA, and a STATA DTA file containing the data. I have based my replication from the Excel file. SW are to be commended for taking time to make their data and code available. Where such recordkeeping is not made mandatory by the journal publishing the paper, as is the case in JAE, such records are seldom available. The availability of the date and code made the replication relatively effortless.[6]

SW present a summary of the data in Table 1. There are several entries in the table that I cannot replicate. The values I compute from their data file are given below theirs in bold. The data is broken into three country groupings, which is important later for predictions about how Africa would have grown had it followed the policy choices of the other two country groups. SW explicitly mention the seven fastest-growing developing economies in their sample, and the data file has a dummy for SSA. Hence, the country groupings for these two are known, and I am able to replicate most of the entries in these two columns.[7]

[4] The gap between Africa and East Asia due to policy is estimated by Easterly and Levine (1998) to be 2.5 percentage points and by Bloom et al. (1998) to be 1.65 percentage points.
[5] There is also the issue of whether the econometric technique used by SW is appropriate (e.g., see the comments by Collier and Udry in Bloom et al. 1998) and whether their independent variables are exogenous (Collier and Gunning 1999a, 1999b). Comment on this is beyond the scope of pure replication.
[6] The main failing of the data posting is not listing those countries included in the "Other Developing Country" grouping, and I spent considerable time trying to reverse engineer the grouping based on the data SW produce in their Table 1. I was ultimately unsuccessful, and ended up forming my own grouping based on country classifications by the United Nations in their 2005 Human Development Report.
[7] The averages for each grouping are taken from the entire sample, and include all countries for which there is data. The country sample is therefore not consistent across measures.

SW Table 1: Africa compared with other developing countries (where my calculations differ, they are given in bold)

	Africa	Fastest-growing Economies	All Other Developing Economies
Real growth per capita 1965-90	0.80	5.83 (**5.82**)	1.76 (**1.30**)
Real GDP per economically active population 1965 (PPP $85)	1480 (**1766**)	2703 (**3053**)	2585 (**3693**)
Openness to international trade	0.07	0.81 (**0.96**)	0.17
Fraction of land-locked countries	0.33	0.00	0.11 (**0.09**)
Life expectancy (circa 1970)	41.6 (**41.9**)	57.1 (**57.7**)	51.9 (**53.7**)
Central government savings	4.14	4.97	1.18 (**2.46**)
Fraction of countries in tropical climates	0.89	0.69	0.59 (**0.61**)
Institutional quality index	4.54	6.86	4.29 (**4.49**)
Natural resource abundance	0.18	0.09	0.12 (**0.20**)
Average annual inflation	149.07 (**10.29**)	54.69 (**10.40**)	91.79 (**19.25**)
Growth of neighboring economies, 70-89	0.50	3.81	1.80 (**1.48**)
Average national savings ratio 1970-90	7.18	22.64	10.13 (**12.79**)
Index of ethno-linguistic fractionalisation	64.54	42.86	32.44 (**32.16**)
Growth of economically active population – total population growth	-0.09	0.82	0.33 (**0.34**)

The two notable differences between their calculations and mine are the initial GDP per capita figures and the inflation figures. SW's data file contains log GDP per capita, which they average and then anti-log. The correct procedure for calculating this average for a group of countries is to anti-log the data and then average it. The same mistake was made with the average life expectancy calculations. The inflation numbers SW present are incredible. The averages that I compute from the data set are reasonable.

The countries contained in All Other Developing Economies are not given in SW. I have taken the United Nations Development Program list of developing countries, flagged

these in the data set, and then excluded SSA and the seven fastest-growing countries.[8] This appears to be a different country set from that considered by SW, as evidenced by the fact that the data averages I compute in the last column of Table 1 are vastly different from the averages SW list. Experimentation with the country list did not reveal a country grouping that produced their results; there is no single country that can be dropped to raise the average growth rate to 1.76, for instance. The differences in the SW values and my calculated values may be important, as they will affect the counterfactuals created when SW apply their regression results to the differences in group averages. One point is that while Africa did grow more slowly than other developing countries, it did not grow that much more slowly. It was also less resource intensive than other developing countries, not more resource intensive, and had lower inflation, not higher inflation.[9]

As a final note on the data, the life expectancy data is reported by SW to be circa 1970 and provided by Jong-wa Lee. Lee published a paper in 1994 with Robert Barro at the NBER, and NBER maintain a data archive there (http://www.nber.org/pub/barro.lee/ZIP/). From the archive it is clear that the life expectancy data SW use here is the average life expectancy at birth averaged over 1960 to 1964. Also, the average national savings ratio is listed in the SW data appendix as being from 1970 to 1989, not to 1990 as listed in Table 1. The Excel file also codes the variable as being to 1989. I have not checked the original source file, which is a World Bank CD ROM that is no longer available, to see which of these is correct.

Theoretical Background

SW then go into the theoretical background for their regression specification. One of their propositions is that the time path of income per worker converges to a steady state that is a function of the national savings rate. They propose that government savings and life expectancy help determine the savings rate, and produce a regression in footnote 8 supporting this proposition. I am unable to replicate the reported regression results, both when using the full data sample and when excluding the five outliers listed in footnote 9. The regression results I obtain using the full sample are:

$$\text{Saving/GDP} = -123 + \underset{(6.5)}{34}\ \log(\text{life}) + \underset{(4.8)}{1.04}\ \text{government saving/GDP} \quad R^2 = 0.36$$

[8] The group of countries in the SW data set that I consider to be "other developing countries" is Afghanistan, Algeria, Antigua and Barbuda, Argentina, Bahamas, Bahrain, Bangladesh, Barbados, Belize, Bhutan, Bolivia, Brazil, Brunei, Cambodia, Chile, China, Colombia, Costa Rica, Cuba, Cyprus, Dominica, Dominican Rep., Ecuador, Egypt, El Salvador, Equatorial Guinea, Eritrea, Fiji, Grenada, Guatemala, Guyana, Haiti, Honduras, India, Iran, Iraq, Jamaica, Jordan, Kiribati, Korea Dem. Rep., Kuwait, Laos, Lebanon, Libya, Maldives, Marshall Islands, Mexico, Micronesia, Mongolia, Morocco, Myanmar, Nepal, Nicaragua, Oman, Pakistan, Panama, Papua New Guinea, Paraguay, Peru, Philippines, Qatar, Sao Tome and Principe, Saudi Arabia, Solomon Is., Sri Lanka, St. Kitts and Nevis, St. Lucia, St Vincent and Grenadines, Suriname, Syria, Tonga, Trinidad and Tobago, Tunisia, Turkey, United Arab Emirates, Uruguay, Vanuatu, Venezuela, Vietnam, Western Samoa, and Yemen.

[9] Inflation turns out to be a statistically insignificant variable, and so this last point is moot.

Their point about overall savings being determined by life expectancy and government savings remains intact, though the r-squared that they report for the relationship is significantly higher than that here. There are no other empirical results in this section.

Regression Estimates

SW first conduct a test for influential data points using the DFITS test in STATA. They find five countries that have DFITS statistics greater than 0.9 in absolute value, and remove these from their main regressions (they include the five in supplemental regressions in an appendix). The recommended sample-adjusted cutoff (Belsley et al. 1980) is actually $2\sqrt{12/84} = 0.76$, and by this criterion Zambia, Malaysia, and Niger could also have been removed. I have tested their first regression in Table 2 with these additional three countries removed and find that some of the coefficient values change dramatically, though none lose their statistical significance. I do not pursue the effect of these influence points further, though the sensitivity of growth regressions to sample has been noted in recent research (Knabb 2005, Norman 2009). Temple (1998) nevertheless reports that the baseline regression in SW is robust to sample.

The main regression results are given in SW Table 2. I am able to replicate each of their first five regressions save for rounding errors in the second decimal place for three t-statistics. The final regression, in which inflation is added as a conditioning variable, is well off. This may be related to the very different inflation averages that I obtained in Table 1. Table 2 below presents the SW results from regression 6 in their Table 2, and then my results. The only major changes are that the coefficient on landlocked becomes statistically insignificant, the only regression in which this is the case, and the coefficient on the interaction term turns from insignificant to significant, as it is in all of the other regressions. Their conclusion here, "that average inflation does not add anything to the explanation of growth after controlling for our ten variables" (p. 351) still holds.[10] Once again the life expectancy variable is an average from 1960 to 1964, and not circa 1970. Inflation is also reported to be from 1965 to 1990 in the data appendix, as opposed to from 1970 as listed in SW's Table 2.

I am also able to replicate the results for the first five regressions using the full sample, given in SW Appendix Table A1, save for two differences in the reported t-ratios at the second decimal point. The appendix inflation regression (6) is again widely off, but the coefficient on inflation remains statistically insignificant. The main difference in the Appendix is that the national savings rate becomes statistically significant when added to the baseline regression, whereas SW make a point of noting that it is insignificant and that such insignificance supports the idea that their nine variables are capturing differences in savings rates across countries (recall the argument earlier that life expectancy and government savings determine overall savings rates).

[10] SW repeatedly reference the "ten" variables in their regression, apparently counting the square of life expectancy as an independent variable. We denote that there are nine variables and eleven covariates.

SW Table 2: Regression estimates, SW Table 2 regression 6, with replication results. Dependent variable: growth per capita of PPP-adjusted GDP, 1965-90. T-statistics in parentheses.

	SW	Replication
Log of real GDP per economically active population in 1965	-1.71 (-8.05)	-1.64 (-7.43)
Openness times log GDP per e.a. in 1965	-0.62 (-1.95)	-0.81 (-2.42)
Openness to international trade	7.21 (2.76)	8.77 (3.20)
Landlocked dummy variable	-0.60 (-2.71)	-0.47 (-1.94)
Log life expectancy circa 1970	47.85 (2.71)	43.87 (2.41)
Square of log life expectancy	-5.71 (-2.52)	-5.15 (-2.20)
Central government savings, 1970-90	0.12 (5.30)	0.12 (4.85)
Dummy for tropical climate	-0.91 (-3.75)	-0.81 (-3.37)
Institutional quality index	0.28 (3.94)	0.26 (3.48)
Natural resource exports / GDP 1970	-3.36 (-3.45)	-3.38 (-3.44)
Growth in e.a. pop – pop growth	1.36 (4.14)	1.11 (3.24)
Average inflation 1970 - 90	-0.0002 (-0.61)	-0.0044 (-0.88)
Adjusted R^2	0.89	0.88
Number of countries	77	74

Once the regression results are listed SW go on to explore their implications for Africa. They first note that the effect of openness is quite large. Given the coefficients in regression 1 of their Table 2, the effect on growth of an average country moving from a completely closed to completely open regime is given as 2.21 percentage points per year (= 8.48 – 0.77*8.05). The correct computation of that equation yields 2.28 percentage points, and at the full precision of the results yields 2.31 percentage points. SW note that this is far larger than moving from being landlocked to open to the sea (0.58 percentage points) or moving out of the tropics (0.85 percentage points).

Table 3: Absolute percentage point impact on growth of a one standard deviation change in the variable, evaluated at the sample average. Extended sample refers to the regression results in Table 5 below with 13 African countries added.

Variable	SW Result	Replication Result	Replication Result with Extended Data Sample
Openness	0.9	0.9	0.9
Life expectancy	0.7	0.6	0.8
Institutional quality	0.6	0.6	0.6
Central govt. savings	0.6	0.7	0.6
Resource abundance	0.5	0.5	0.4
Differential pop growth	0.4	0.4	0.5
Tropical climate	0.4	0.4	0.5
Landlocked	0.3	0.2	0.2

The discussion over the next few pages of the section involves the quantitative importance of the nine variables in their baseline regression. These are all replicable save for the following items. The discussion on page 350 reports the impact of a one standard deviation change of each variable on growth in order to rank the variables by importance (see Table 3). In the replication of these calculations life expectancy is associated with a 0.6 percentage points increase in growth (not 0.7 as reported), government savings with a 0.7 percentage points increase (not 0.6), and being landlocked is associated with a 0.2 percentage points decrease in growth (not 0.3).[11] This downgrading of the impact of cross-country differences in life expectancy and being landlocked, and the upgrading of government savings, strengthens SW's conclusion that policy variables like openness (0.9 percentage points), institutional quality (0.6 percentage points), and government savings (0.7 percentage points) are more important than geography and more or as important as life expectancy (0.6 percentage points).[12] Life expectancy itself reflects to some degree public health policy, and so one might even conclude that the four most important variables impacting growth over the measurement period are related to policy.

SW then propose that their list of regression variables obviates the need for a SSA dummy to explain Africa's slow growth, as was common in the literature that preceded their paper. To demonstrate this SW's regression 2 in Table 2 adds a SSA dummy, on which the coefficient is statistically insignificant at a t-ratio of 0.05. They then argue that

[11] Initial level of income, which is another variable, has the strongest impact at 1.7 percentage points. SW do not compute this statistic for this variable.

[12] Butkiewicz and Yanikkaya (2010) argue that the SW index of trade openness is poorly correlated with trade measures, and is instead a measure of the quality of overall institutions and economic policies. Rodrik (1998) suggests that Sachs and Warner are measuring macroeconomic adjustments and structural reforms. Butkiewicz and Yanikkaya find that openness to trade reduces the rate of economic growth in developing countries. Falkinger and Grossman (2005) provide a model of why this can be the case.

this is due to their modeling of trade openness and life expectancy: "…if we start with regression 2 in Table 2 and simply drop the SOPEN variable, the t-ratio on the Sub-Saharan Africa variable rises to -2.2. If we do the same with the life expectancy variable, the t-ratio on the Sub-Saharan Africa variable rises to -1.4." Repeating their experiment, I find that omitting the openness variable from regression 2 causes the SSA dummy coefficient t-ratio to fall to -1.96, which is still insignificant at the 5% level. Omitting the life expectancy variable causes the t-ratio to fall to -0.95, which is still far from significant. If openness and life expectancy are *both* removed, the dummy comes significantly into play at a value of 1.5 percentage points. This highlights the importance of modeling at least one of these variables when seeking to avoid the need for an Africa dummy, and indicates that what is special about Africa is its trade policies and life expectancy.

SW's treatment has been criticized by some as replacing the Africa dummy with a tropics dummy, and for that reason SW do not really get rid of an Africa dummy in their regressions. This criticism is unfounded on two fronts. First, the tropics variable is a continuous variable that can be non-zero for countries not in Africa. It is not a dummy variable specific to SSA. Second, if I remove the tropics variable from regression 2 in SW Table 2 the SSA dummy remains statistically insignificant.[13]

Since openness ranks quite highly in terms of its impact on growth, SW explore why African countries had less openness than other developing countries. They argue that countries with a colonial past were more likely to pursue closed trade policies, and that this statistically dominates explanations relating closed policies to ethnic diversity. On page 353 they regress openness on ethnic fractionalization and colonial origins. They indeed find that the coefficient on colony is negative and statistically significant, while the coefficient on ethling is negative but not significant. When I replicate their regression I obtain

$$\underset{}{\text{open6590} = 0.63 - 0.003\ \text{ethling} - 0.26\ \text{colony} \quad R^2 = 0.20}$$
$$\underset{}{\qquad\qquad\qquad\qquad\quad (-1.97) \qquad\quad (-2.72)}$$

The coefficients on colony and ethling are substantially different from those reported in SW, as are the t-ratios. The coefficient on ethling is now just barely insignificant, at 5.15%. This weakens the evidence that colonial origins were the main or only cause of closed trade policies.

While there were several computations in this section that could not be replicated, no finding is overturned, though some are modified. Policy is important, especially trade openness, which appears to be conditioned on colonial heritage *and* ethnic fractionalization. There is no need for an Africa dummy as long as the model includes *at least one of* openness and life expectancy.

[13] This is true if the landlocked dummy is also removed, and so it is neither being in the tropics nor absence of access to the sea that makes Africa special. This point has been previously made by Paul Collier in Bloom et al. (1998, p. 275).

The Problem of Missing Countries

The next section of the SW paper investigates possible bias from only having 23 of the 46 SSA countries in the baseline regression sample. In Table 3 they compute the root mean squared error (RMSE) for the growth predictions from regression 1 in Appendix Table A1. That regression includes the five influential points that were omitted in the previous analyses. It is not clear why they change the sample here. The predicted growth data in Table 3 are correct save for Cote D'Ivoire, which should be 0.02 rather than -0.02, and Madagascar, which should be 0.51 rather than 0.47. The averages calculated at the bottom of the table are not correct. The average for the Actual Growth should be 0.64, not 0.41, and the average for the predicted growth should be 0.67, not 0.44. The RMSE is 0.91, not 0.89. Despite these errors, their statement that "predicted growth … is close to actual growth … for this subset of countries" (p. 353) is correct. Using the baseline regression that omits the five influential points, and thus excludes Botswana, Gabon, and Madagascar, I compute the RMSE as 0.68.

SW Table 4 lists the 23 SSA countries that are listwise deleted from the baseline regression due to missing data. Thirteen of these were missing data for three or fewer variables, and SW replace these missing entries with the averages for all other African countries. Table 4 is not replicable either using the full sample or the sample without the five influence points. I present my results in bold where they differ from SW's results. To be consistent with SW Table 3, I use the full sample baseline regression. SW note that the predicted growth is higher than the actual growth for these 13 countries. This is still true given the corrected values in the Table.

SW report that the standard error for the baseline regression with all regions of the world is 0.67. This is not correct. It is either 0.63 (with influence points excluded), 0.77 (with five influence points included), or 0.82 (with five influence points included and the imputations for 13 missing African counties included). They compare this with the standard error for the 23 African countries listed in Table 3. They report this as 0.89. I calculate it to be 0.91. They then refer to the standard error for the 23 (should be 13) countries in Table 4 as 1.00 (I compute it to be 0.94). They conclude that "This figure is slightly higher than 0.67, but not tremendously higher when one considers the inevitable errors that arise from our data imputations" (p. 356).[14] They are comparing 1.00 with 0.67, whereas the comparison should be 0.94 with 0.77. This difference is smaller, supporting their conclusions that the model performs well enough even for the 13 African countries with imputed data. The African countries whose growth is not well explained are Benin, Chad, Gabon, Madagascar, and Mozambique.

[14] This method of imputation actually biases the RMSE downwards because constants are replacing variables (Firebaugh 2008).

SW Table 4: Actual and predicted growth for African countries not in the regression sample (where my calculations differ they are given in bold)

Country	Actual Growth	Predicted Growth	Number of times that missing data were replaced by Africa averages
Angola			
Benin	-0.96	0.96 (**0.70**)	1
Burundi	1.39	2.15 (**1.97**)	1
Cape Verde Islands	3.63		
Central African Republic	-0.50	0.05 (**-0.06**)	1
Chad	-2.37	-0.60 (**-0.66**)	2
Comoros	-0.53		
Djibouti			
Ethiopia			
Guinea	1.36	1.75 (**1.70**)	1 (**3**)
Guinea-Bissau	0.49	1.26 (**0.76**)	2
Lesotho	3.45	3.16 (**3.40**)	3
Liberia			
Mauritania	-0.43	-0.49 (**-0.81**)	1
Mauritius	2.50	1.92 (**1.80**)	1
Mozambique	-2.03	-0.59 (**-0.55**)	2
Namibia	0.88		
Reunion			
Rwanda	3.05	2.07 (**2.10**)	1
Seychelles	4.39		
Sudan			
Swaziland	1.71	0.61 (**0.59**)	3 (**2**)
Togo	1.07	1.04 (**1.11**)	1
Average for 13 countries with 3 or fewer imputations	0.67	1.02 (**0.93**)	
RMSE	1.00 (**0.94**)		

Something that SW don't do, but is of interest given the possibility that the listwise deletion of these 13 countries causes bias in the estimators (Firebaugh 2008), is to compare the regression results in Table 2 with the results after adding the 13 missing African countries. I have done this for regressions 1 and 2 in Table 2. In regression 2 the SSA dummy remains statistically insignificant and all other variables remain significant. Table 5 below presents the regression results from regression 1 with and without the

Table 5: Regression estimates, SW Table 2 Regression 1, with original data set and with extended country sample that includes 13 additional African countries with imputed data. Dependent variable: growth per capita of PPP-adjusted GDP, 1965-90. T-statistics in parentheses.

	Original data set	Extended data set
Log of real GDP per economically active population in 1965	-1.63 (-8.47)	-1.73 (-9.38)
Openness times log GDP per e.a. in 1965	-0.77 (-2.54)	-0.69 (-2.19)
Openness to international trade	8.48 (3.44)	7.81 (3.03)
Landlocked dummy variable	-0.58 (-2.69)	-0.52 (-2.53)
Log life expectancy circa 1970	45.48 (2.60)	58.61 (3.30)
Square of log life expectancy	-5.40 (-2.41)	-6.98 (-3.04)
Central government savings, 1970-90	0.12 (5.40)	0.11 (5.21)
Dummy for tropical climate	-0.85 (-3.64)	-0.99 (-4.32)
Institutional quality index	0.28 (3.95)	0.27 (3.74)
Natural resource exports / GDP 1970	-3.26 (-3.41)	-2.33 (-2.56)
Growth in e.a. pop – pop growth	1.19 (3.82)	1.32 (4.21)
Adjusted R^2	0.89	0.87
Number of countries	79	92

additional 13 African countries. From the results in the second column I recomputed the importance of the independent variables for determining growth, and the ranking remains intact (see Table 3): openness is the most important variable (0.9 percentage points), followed by life expectancy (0.8 percentage points), and then the policy variables government savings (0.6 percentage points) and institutional quality (0.6 percentage points). Tropics are slightly more important (0.5 percentage points), and natural resources (0.4 percentage points) and being landlocked (0.2 percentage points) are slightly less important when the additional countries are included. In any event, the missing African countries were not biasing the results in any meaningful way.

Policy Implications

While I have not been able to replicate many of the results in SW, none of their findings so far have been overturned. In this section SW take into account regional geographic, demographic, and policy data and use the regression results to undertake a comparison of Africa's growth compared with growth of the fast growers in Asia and the other developing economies. Table 5 in their paper reports the results. Recall that in Table 1 some of the covariate averages reported by SW are different from those I compute in this replication. This will affect my counterfactual calculations in this section.

To begin, I use their data in Table 1 to confirm that my method of replication is correct. I apply their regression results from Table 2, column 1 to the average variable values from the sample of African countries and the sample of other developing countries. Table 6 compares Africa's growth factors determined by geography, changing demography, and health of the population with the growth factors of all other developing economies. Here the replication is successful, with changing demography, geography, and health dealing SSA a 2 percentage point per year blow in growth compared with other developing economies. Table 7 then compares the impacts of policy. Here, I impose on Africa the average policy level in all other developing economies as SW report in Table 1 and then apply the baseline regression coefficients. The resulting growth differences due to policy cannot be replicated.[15]

What happens if I use my computations of the covariate averages listed in Table 1? Table 8 reproduces Table 6 given this change. The results for geography, demography, and public health are not greatly different. However, in Table 9, which reproduces Table 7 with the corrected covariate values, if Africa followed the policies of the average other developing country it could have grown at 0.80 + 0.05 = 0.85%, not 0.80 +0.60 = 1.4% as claimed by SW. The main difference in growth between Africa and the other developing countries was not due to overall policy but due to changing demography and poor public health (see the last two rows of Table 8, which add up to a growth differential of 1.5 percentage points). These corrections put the SW results in line with those of Bloom et al. (1998). They also resolve Collier and Gunning's (1999a) mention of the exceptionally large impact that SW attribute to trade policy, being landlocked, and resource dependence on African growth, at 1.2 percentage points per annum. Collier and Gunning suggest that 0.4 percentage points would be more typical. My replication in Tables 8 and 9 shows that the combined effect of these three factors in the SW analysis is 0.4 percentage points.

If I repeat this exercise by comparing Africa to the seven fastest-growing countries using my data from Table 1, I get the results shown in Table 10. Africa would not have grown at the 4.3% claimed by SW if it had followed fast-growth policies, but it would have grown at 4.0%.

[15] The institutional quality number is incorrect by inspection. Using SW's numbers in Table 1 the index of African institutional quality is better than that of other developing countries. It is therefore impossible to get a negative impact of institutional quality on African growth, though SW indicate a negative impact in their Table 5. Another observation is that the impact of openness on the rate of convergence appears to be taken into account twice in the table, once on the interaction term and once on the convergence term.

Table 6. Effect of differences in geography, changing demography, and public health on the rate of growth, in percentage points, Africa versus average other developing economy using SW reported averages for the levels of the independent variables in Table 1.

Geography, Changing Demography, and Health Effect	SW Estimate	Replication Estimate
Tropics	-0.2	-0.25
Landlocked	-0.1	-0.13
Natural resource endowments	-0.2	-0.20
Growth in non working-age population	-0.6	-0.50
Life expectancy	-0.9	-0.90
TOTAL	-2.0	-1.98

Table 7. Effect of policy and governance differences on the rate of growth, in percentage points, Africa versus average other developing economy using SW reported averages for the levels of the independent variables in Table 1.

Policy and Governance Effect	SW Estimate	Replication Estimate
Trade openness	-0.9	-0.35
Government saving	+0.2	+0.36
Institutional quality	-0.0	+0.07
TOTAL	-0.7	+0.09

Table 8. Effect of differences in geography, changing demography and public health on the rate of growth, in percentage points, Africa versus average other developing economy using my calculated averages for the levels of the independent variables in Table 1.

Geography, Changing Demography and Health Effect	
Tropics	-0.24
Landlocked	-0.14
Natural resource endowments	+0.07
Growth in non working-age population	-0.51
Life expectancy	-0.95
TOTAL	-1.77

Table 9. Effect of policy and governance differences on the rate of growth, in percentage points, Africa versus average other developing economy using my calculated levels of the independent variables in Table 1.

Policy and Governance Effect	
Trade openness	-0.27
Government saving	+0.21
Institutional quality	+0.01
TOTAL	-0.05

Table 10. Effect of policy and governance differences on the rate of growth, in percentage points, Africa versus average seven fastest-growing non-African economies.

Policy and Governance Effect	SW Estimate using Their Values in Table 1	Replication Estimate using My Values in Table 1
Trade openness	-2.8	-2.44
Government saving	-0.1	-0.10
Institutional quality	-0.6	-0.66
TOTAL	-3.5	-3.20

Concluding Remarks

The Concluding Remarks of the SW paper state that poor economic policies have had a larger negative impact on Africa's growth rates than have geographic factors. This does not stand up to replication, at least in terms of explaining the growth differences between Africa and the developing countries other than the fastest-growing Asian economies. Growth in Africa over the sample period would only have been 0.85% had it followed the policies of these other developing economies, not 1.4% as claimed by SW. Geography was responsible for a 0.3 percentage point growth lag, six times the impact of policy differences. Changing demography and poor public health were responsible for a 1.5 percentage point growth lag. This is not to say that the regression results do not show policy to be an important determinant of economic growth. It is just that Africa's policies were on the whole not that different from other developing countries over the sample period, while its geography, changing demography and public health were.

SW also state that neither neighborhood nor regional effects caused any additional drag on Africa's growth given the set of independent variables in their regressions. This is supported by my replication.

The final section of SW's Concluding Remarks notes the caveat that regardless of actions taken on the policy front Africa will continue to suffer from three structural conditions: being landlocked, a high natural resource dependence, and low life expectancy. A review of Table 1 shows that Africa is actually relatively light on resource dependence compared with the rest of the developing world. That is, the resource curse is not an Africa problem to the same extent that being landlocked and having low life expectancy are. SW recommend that all of these structural determinants can be offset with government planning. This replication shows that infrastructure financing, public health financing and efforts to control or eradicate major tropical diseases should take priority in any special

development plan for Africa. Managing natural resource wealth and spurring non-traditional exports in an effort to avoid the resource curse is a solution to a problem that Africa is not particularly afflicted by.[16]

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[16] There is also evidence that high resource dependence may lead to slower economic growth through accounting artifacts associated with diminishing per capita resource output rather than through nefarious mechanisms associated with political economy (Alexeev and Conrad 2009, Davis 2011, Haber and Menaldo 2011, James and James 2011). As such, only sustained or growing per capita resource output will prevent the resource curse.

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