Intensity of technology use and per capita real GDP across some African countries

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Abstract: African countries may have fared poorly compared to some countries in other regions, but relative to their own performance history some African countries have done quite well over the past eight years. In particular 2004 and 2005 were especially good years. How can such performance be made to stick and even expand? The answer to that question requires better understanding of the source of good performance. This paper proceeds on the assumption that technology was, at least partially, responsible. The result shows that a feeble technology undercuts per capita real GDP across African countries. However, the impacts of new technologies, measured by the intensities of internet and cell phone use are very strong. The policy implication of the findings speaks to the need for investment in new technologies for which productivity is high and the adoption and diffusion costs seem low. Further research can clarify the findings and policy by expanding and improving the data coverage, and examining effects on income of different kinds of technologies.

Keywords: technology and per capita income, GDP per capita Africa, African countries' GDP-technology nexus

JEL Code: O15, C21, O55, C51, O47, O41

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1. Introduction

African countries suffer from *Africa-itis*. *Africa-itis* is a stigma that preceded and will most likely outlast HIV/AIDS. On one hand the stigma makes it hard for observers to notice good economic performance of African countries, and on the other it makes it obsessively easy to point out the bad news. It is not only that “Africa surely suffers from a remarkable inattention of the international scientific community” as David Bloom and Jeffrey Sachs (1998, p. 37) point out, it is also that the little attention African countries receive is inordinately normative and pessimistic. Rarely do even of the best of expert writings on African countries, for example, reveal that although over the 1960-1990 decades African countries made up a large percentage of the “growth disasters”, some African countries did make the list of the “growth miracles” (see Temple, 1999, Table 2, p. 116). African countries may have missed surfing early on the bubbly wave of the dotcom years, however, during the late 1990s up to 39% of African countries did catch at least the backdraft of the wave. Indeed, many African economies grew at rates no lower than two percent per annum, and strong growth continued through 1998. As the dotcom wave subsided, growth slowed to 3.2% in 2002, before climbing back up to 4.3% in 2003, 4.6% in 2004, and higher still in 2005 (United Nations Economic Commission for Africa - UNECA, 2005). In sum: over the past eight years to date African countries have grown at annual rates exceeding four percent (OECD Observer, 2005). Moreover, by 2004 there were only three truly troubleshoots in Africa (the Darfur region of the Sudan, Zimbabwe, and the Cote d’Ivoire). Yet, the whole of Africa is more likely to be defined by these three spots than Asia is likely to be characterized by Afghanistan, Pakistan, Indonesia, Burma, North Korea - all truly red hot spots.

The bias in economic reporting on African countries is systematic as it is inexplicable. Table 1 indicates that the African continent itself is competitive in the marketplace of attitudes. Using the Google Search facility one finds that for every “Africa bad continent” hit there are three and a half hits for “Africa good continent”. This ranks Africa as the must positively perceived continent.

However, Africa's the ratio of good-to-poor economic performance is only 1.39, placing the continent at the bottom - the *Africa-itis*. *PUT TABLE 1 AROUND HERE**

Even against such background, research is still unable to hide that "Africa" average performance figures mask diverse performance across regions and countries, see, e.g., UNECA (2005) and IMF (2005) . Botswana has been one of the best performers in the world for nearly four decades. Central Africa has grown at an annual average rate of more than 14% during the 2004-2005 year as Figure 1 shows.[1] The differences in performance should not be surprising as standard economics teaches that the production possibilities of any economy depend on its technical capability. Technical capability is defined by the quantity and quality of available resources and the level of technology. Economic growth is the expansion of production possibilities resulting from improved technical capability, and subject to the initial and current institutional conditions, and the policies that govern both. Because capabilities differ across economies so too does economic performance. Yet, too often analyses of the sources of the economic performance of African countries focus either on external factors for which subsequent policy is exogenous, or on some loose generalizations of internal sources of growth for which useful policy is nearly impossible to conduct. For instance, the UNECA study lists "macro-stability" and "tourism" as the main internal sources of growth for Africa in 2004, but then the report goes on to lament the weak domestic investment, low domestic savings, and the risk of currency appreciation as "some areas of concern". Research must do better than this if it is to serve a credible policy function.

PUT FIGURE 1 AROUND HERE

While the quality of resources, such as human capital, which individual African countries have is a matter of considerable debate, quantitatively most African countries are no more resource poor than their counterparts in other regions of the world. For the most part African countries had colonial experiences not unlike those of other developing countries, suggesting congruent initial conditions across some world regions. Additionally, many developing countries around the world pursued similar economic and political policies immediately post-independence. The movements toward resource nationalization and import substitution policies were not unique to African countries. This all seems to imply that observed economic growth rate differences are not principally due to resources, initial conditions, or policy. A reasonable constraint on the economic growth of African countries has been the fact that technological change has never “etherealised” progressively and adequately.[2] For example, a quick glance at the sources of economic growth of the USA would show a clear shift from reliance for growth on resources (Romer’s objects) in the early years to ideas in the middle years, and increasingly to healthy interactions and intra-actions of ideas and objects in more recent times (Denison, 1967, Gordon, 2002, Aghion, 2006). Since nothing of the sort has been documented for African countries, it seems reasonable to pose as a hypothesis that *a major obstacle to the economic performance of African countries is a feeble technological foundation*. Just as even the craftiest of construction engineers cannot erect a skyscraper on Jell-O, so too strong and sustained growth needs a strong technological infrastructure.

The objective of this paper is to quantify some of the technological foundations of economic performance in 2004/5 across the 46 African countries listed in the appendix to this paper. The objective is important because technology improves the productivity of other resources. It is especially crucial where the relative productivity of other factors of production is a matter of considerable concern. As Aaron Segal (1985) points out "of all gaps that separate Africa from the rest of the world the science and *technology* is probably the most critical, and the most profound " (p. 110, italics added). Section 2 outlines the theory behind the paper. Section 3 turns to practical issues including data, estimations, and results. The final section makes concluding remarks.

2. Theory

This section first sketches the relevant literature and then states a simple and practical model.

2.1. Literature

Paul Collier and Jan Willem Gunning (1999) review a very large set of literature on African performance seeking to uncover commonalities of the sources of economic performance. They relate sources of the economic decline of Africa to the lack of social capital, trade openness, public services, financial depth, presence of a risky geography, and over-dependence on foreign aid. What stands out from this literature review at the aggregate is the negative effect on performance of the so-called "Africa dummy". Consistent with Collier and Gunning many other researchers report a significant African dummy ranging in size from -0.54 to -0.0052 over the 1960-1989 decades (Benhabib and Spiegel, 1994, Alcala and Ciccone, 2001, Barro, 1991, Easterly and Levine, 1997). Also during the 1960-2003 years Africa's total factor productivity (TFP) has remained low between -1.34 and -0.05 according to some estimates (Ndulu and O'Connell, 1999, Soderbom and Teal, 2003, Jorgenson and Vu, 2005).[3] The negative effects of Africa's TFP and dummy are discernible despite the fact that other sources of growth, such as physical capital per worker or human capital per worker, are not that different from those of other regions.[4]

Temple (1999) looks at the new growth evidence from the perspectives of the old (exogenous) neoclassical and new (endogenous) growth theories. The evidence concludes that differences in economic growth are mainly due to differences in capital investment in equipment, people, and R & D; high inequality of income and the implication of that for (in-)stability; economic freedom and security of property rights; government and its effect with respect to taxation, spending, regulation, and the financing of infrastructure; and openness to trade.

However, Temple's "new evidence" is not really new; W. Arthur Lewis (1965) argues that "the proximate causes of economic growth are the effort to economize, the accumulation of knowledge, and the accumulation of capital" (p.164). These causes have strong basis in the quantity and quality of human population and other natural resources, and in government and government policy. It is not surprising that Temple and Johnson (1998) in associating economic growth to social capability, start where Lewis was, or at least where he wanted to go. Here is one important sign Lewis posted:

> Economic growth depends both upon technological knowledge about things and living creatures, and upon social knowledge about man and his relations with his fellowmen. The former is often emphasized in this context, but the latter is just as important since growth depends as much upon such matters as learning how to administer large scale organizations, or creating institutions which favour economizing effort, as it does upon breeding new seeds or learning how to build bigger dams (p.164).

The interesting part of this thoughtful line of work is how seemingly non-economic factors affect the relationship between economic growth and technology (cf. Hoselitz, 1952, Fafchamps, 2000). In a recent paper Bart Los and Bart Verspagen (2001) "distinguish four ways in which technology and innovation have their impact on growth" (p. 2). The first channel treats technology either as a pure public good and in that case its rate of change is exogenous, or as a quasi-public good, the rate of which is endogenous. In both cases technology drives the steady state rate of growth. In turn technology is a function of factor ratios so that in the exogenous version as the capital-labour ratio increases, the rate of technical change first rises and then falls as diminishing returns to scale set in (Solow, 1957, Swan, 1956). In the endogenous version factor ratios such as the human capital-labour ratio are dynamic with the potential for postponing diminishing marginal products and sustaining convergent/divergent (steady) states (Romer, 1989, 1990, Lucas, 1988, 1993). Bennett McCallum (1996) and Mark Rogers (2003) provide excellent reviews of neoclassical exogenous and endogenous growth theories, while Nazrul Islam (2004) assesses the normative (policy) value of endogenous growth theories to developing countries.

A second channel which Los and Verspagen point out is technological diffusion which enables lagging economies to catch-up with frontrunners. However, the rate at which economies close the technological gap between them is a function of "social capability" and "technological congruence" (see Los and Verspagen, 2001). Social capability is the basis for technological "absorptive capability" (Kneller and Stevens, 2006), and it has two interactive dimensions: the infrastructural base of which fixed capital such roads, railways, and so on are a major part, and the superstructural base including institutions, social capital, and the like. Congruence implies applicability of technology developed elsewhere.

As third and fourth ways in which technology and innovations enter economic growth Los and Verspagen point to learning-by-doing and roundabout production. Combined these two channels permit a demand-driven cumulative impact of technology on economic performance, variously called the Verdoorn-Young-Arrow learning effect, or the Myrdal-Kaldor secular and causal effect (Young, 1928, Arrow, 1962, Kaldor, 1966, Thirlwall, 1978).

Measures of technological capability differ and rank countries differently as Daniele Archibugi and Alberto Coco (2005) describe (cf. Jeffrey Jones, 2006). What is disturbing, however, is that African countries invariably rank low on all key indices of technology. The Technology Achievement Index (TAI), inspired by the U.N. Development Programme (UNDP) and outlined in Desai, Fukuda-Parr, Johnson, and Sagasti (2002) focuses on 72 countries, dividing them into groups: “leaders”, “dynamic adopters”, “marginalised”, and “others’. This index has four dimensions (technology creation, diffusion of new technologies, diffusion of old technologies, and technology relevant human skills). A few African countries on the list score low. Besides on the TAI, African countries are also not doing well on the Technology Index ($Technology_i$ in this paper) assembled by the World Economic Forum. This paper seeks to understand the effects of technology on per capita real GDP across 46 African countries in 2004/2005. Such an understanding will help focus the search for the location of the negativity of both the Africa dummy and TFP.

2.2. Model

As a starting point assume a homogenous Cobb-Douglas technology for the ith African country to be

$$Y_i = N_i^{\alpha} K_i^{\beta} (Z_i A_i)^{1-\alpha-\beta}, \tag{1}$$

where Y_i is gross domestic product (GDP), N_i is the population, K_i is the capital stock given by the perpetual inventory formula as net new investment plus old capital stock less depreciation, i.e.,

$$NewCapital_i = Net\ Investment_i + [Old\ Capital_i - Depreciation\ of\ OldCapital_i],$$

Z_i is a vector of other output determinants, A_i is the level of technology, and α and β are constant parameters to be estimated.

Dividing through by N_i gives (1) in logarithmic per capita terms as

$$y_i = \beta k_i + \gamma z_i + a_i, \qquad \gamma = 1 - \alpha - \beta, \tag{2}$$

where $y_i = \log (Y_i / N_i)$, $k_i = \log (K_i / Ni)$, $z_i = Z_i / N_i$, and $a_i = \log A_i$. The estimations of this paper focus on six different versions of (2). Next take a look at some practical issues.

3. Practice

This section describes measurement issues, estimations, and results.

3.1. Measurement Issues

The dependent variable y_i is real per capita GDP in U.S. dollars (US$). Chief among independent variables is the capital-labour ratio (k_i). For the lack of data on capital stock, a reasonable measure of k_i is the share of GDP that went to capital formation averaged over the 2000-2003 period.

The vector matrix z_i includes independent variables such as per capita trade *openness* measured as the ratio of per capita exports plus imports to per capita GDP, inflation rate averaged over the 2000-2003 years (ν), and regional dummies (Eastern, Western, Northern, Southern). And finally $a_i = y_i - \beta k_i - \gamma z_i$ is a Hicks-neutral productivity shock - a measure of the technological basis of performance.

For most countries in this sample the main data source for y_i are www.earthtends.wri.org and www.finfacts.com. Missing and incomplete data are supplemented by similar data from the

International Monetary Fund's (IMF) *International Financial Statistics* - IFS (2005). Inflation rate (ν) also comes from IFS (2005). The data for Openness, Cellfone, and Internet come from www.Joinafrica.com.

3.2. Estimations

I use the OLS estimator of (2) in *five fundamental*, and *four auxilliary* versions. In *real* per capita terms all nine versions can be generalized to

$$y_i - \upsilon_i = a_i + \beta[k_i - \upsilon_i] + \gamma[z_i - \upsilon_i] + e_i, \quad e \sim N(0, \sigma_i^2). \tag{3}$$

In other words, y_i depends on k_i, Openness, and an index of macroeconomic environment (Macro) in Version1. The Macro data comes from World Economic Forum. Missing data for the rest of the countries in this study is the Africa average Macro (Amacro), calculated as the average sum of available Macro for *n* countries, i.e., $AMacro = \frac{1}{n}\sum Macro_i = 1.78$. Version 2 adds Technology$_i$, drawn from Global Competitiveness Reports. Where data is missing a proxy was calculated as $ATechno\log y_i = [(\frac{\sum Techno\log y_i}{2n}) - (\frac{\sum NRI_i}{2(1-n)})] = 1.23$, where *n* are countries for which Technology$_i$ data is available, and *1-n* are countries for which Technology$_i$ data is not available, but a partial data series, called Networked Readiness Index (NRI$_i$), is available. For comparison purposes the highest possible score for both Macro and Technology$_i$ is 5.0.

To control for additional variations Version 3 adds regional dummies (Eastern, Western, Northern, and Southern). Version 4 assumes that Technology$_i$ can be decomposed into two measures, viz., Cellfone and Internet. The "Internet" variable is the ratio of internet hosts to internet users, and "Cellfone" is per capita cell phones. Both measure the intensity of use of new technologies.[5] Version 5 includes regional dummies.

Versions 1-5 constitute the *fundamental versions* of the basic model in (2) or (3). Auxiliary Versions 6-9 are not essential estimations; rather, they are indirect checks on the robustness of the fundamental estimations. For example, Version 6 drops Macro, Version 7 drops Openness, Version 8 drops Internet, and Version 9 excludes Cellfone. The next subsection presents and discusses the results. The discussion stresses Versions 1-5.

3.3 Results

Tables 2 and 3 report estimation results of fundamental and auxiliary versions of (3) respectively. Excluding the constant term the second column of the first table shows, for example, that macroeconomic policy has the largest effect on per capita real GDP across these African countries. Per capita capital and openness to trade are also positively related to per capita real GDP. More than one third of a percentage point increase in GDP results from a one percentage increase in k_i and Openness.

A large constant term suggests that some other determinants of real per capita GDP are missing from Version 1. The regression results in the next column of the table add a measure of technology using a technology index calculated by the World Economic Forum (2005). In this case while the coefficients of k_i and Openness remain largely unchanged, the estimate of Macro more than doubles and the constant term falls. A major finding is a huge, negative, and statistically significant impact of technology on the per capita real GDP of these African countries. This implies that the low level of technology harms real income determination in these countries. In fact, the magnitude of this negative coefficient increases significantly when the regression includes regional dummies, suggesting that the sign is not spurious. Southern Africa has the largest regional dummy and Eastern

Africa the smallest. Moreover, macroeconomic policy becomes even more important than in previous versions. Openness to trade remains positive for GDP, but it is no longer statistically significant. *PUT TABLE 2 AND FIGURE 2 AROUND HERE*

Columns 4 and 5 of Table 2 considers explicit components of technology: the intensity of internet use (Internet) and cell phone use per capita (Cellfone). Parameters for both variables are large and statistically strong. Such impacts are unaltered by the inclusion of regional dummies, although in this case trade openness becomes insignificant. Even so, the impact of per capita capital is robust at about 0.37 across all five fundamental versions. The explanatory power ranges from 21% to 54%, not unreasonable for cross-section regressions and a relatively small sample.

From Table 2 one also notices that the coefficients of Internet (3.3161) and Cellfone (5.0941) are large. This raises a question about whether or not these variables are overestimated. The results in Table 3 indirectly address that concern. Version 6 to Version 9 retain k_i and regional dummy variables as the key independent variables and drop one of the remaining variables from each regression. Version 6 drops Macro; Version 7 excludes Openness, Version 8 leaves out Internet and Version 9 goes without Cellfone. The results: compared to Table 2 there is a remarkable improvement in summary statistics in Table 3; both explanatory and predictive power of the regressions, for instance, increase. However, there is no major gain in the technical efficiency of individual parameters. In addition, the values of the log of the likelihood function decline. This seems to indicate that the fundamental versions in Table 2 are more informative than the auxiliary versions in Table 3.

Figure 1 summarizes aggregate results, while Figure 2 displays regional variations. One notices that per capita income falls within a band bordered by antilog ($6.25 ≈ $518.13) in the south and antilog ($8.5 ≈ $4,914.77) in the north. Figure 2a is based on Version 3 and Figure 2b on Version 5. *PUT TABLE 3 AND FIGURES 3A & 3B AROUND HERE*

4. Concluding Remarks

The objective of this paper is to quantify the impact of technology on per capita real GDP of some African countries in 2004/2005. The results are encouraging both for policy and further research. The first estimation begins with per capita capital, trade openness, and macroeconomic policy index as the main independent variables, assuming homogenous technology across countries. These results show that 12% of variations in per capita real GDP are explained by those independent variables. A one percentage rise in capital and trade openness contributes more than a third of one percentage increase in GDP, and for macro-policy the effect is three-fourths of a percentage change.

However, the large constant term motivates the inclusion of a country-specific measure of technology. The negative impact of the technology variable means that technology is a major constraint of the growth of African countries. This conclusion is consistent with previous observations of a negative total factor productivity (TFP) and/or Africa dummy.

Since TFP is a catch-all “measure of our ignorance”, subsequent estimations assess the effects on per capita GDP of the intensity of use of two new technologies: Internet and Cellfone. Along with the macroeconomic environment these two variables explain real GDP per capita across countries well. However, as Figure 2 indicates there are considerable regional variations.

A number of implications for research and policy emerge from these conclusions. For instance, the results suggests a need for improved technology. Increasing the distribution and use of internet and cell phone technologies is one way of improving technology. These new technologies have a good chance of rapid diffusion because “social capability” and “technological congruence” already exist in these countries and the cost of initiating them is lower than the cost of adopting old technologies.

For further research a key implication of the results is a need to investigate the impacts of old technologies, increasing the sample size, and using alternative modelling and estimations techniques, and better data.

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Figure 1 - Average real growth rates across African countries, 1996-2006 (todate), by region

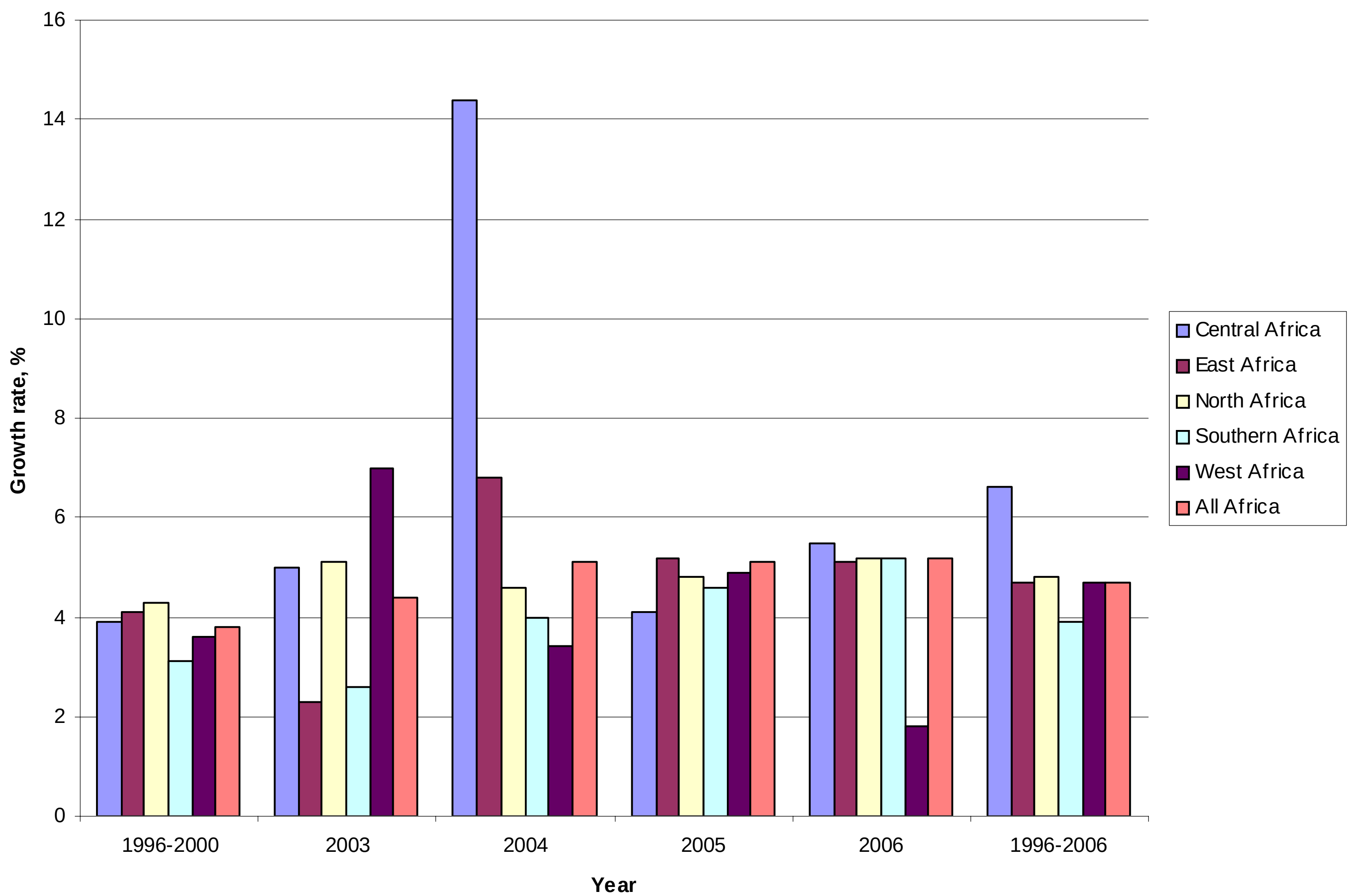


Table 1 - Attitude toward continent and economic performance in millions of Google hits

Continent	Continent attractiveness				Economic performance			
	Good	Bad	Good/Bad	Rank	Good	Poor	Good/Poor	Rank
Africa	78.9	20.7	3.8	1	3.3	2.43	1.4	5
Asia	80.3	22.2	3.6	2	5.1	2.8	1.8	2
Europe	162.0	56.6	2.9	3	6.9	2.5	2.8	1
North America	79.9	27.9	2.8	3	3.3	1.9	1.8	3
South America	83.7	32.3	2.6	4	3.4	2.1	1.6	4
Australia	112.0	43.8	2.6	4	2.1	1.5	1.4	5

Table 2 - Determinants of per capita GDP across African countries, 2004/2005[b] - Fundamental Versions

Variable	Version 1	Version 2	Version 3	Version 4	Version 5
Constant	4.695 (7.745)	4.153 (7.189)	None	5.136 (8.299)	None
Log capital-labour ratio	0.373 (2.148)	0.357 (2.116)	0.358 (2.387)	0.359 (2.029)	0.368 (1.979)
Log Openness	0.365 (2.451)	0.362 (2.519)	0.067 (0.548)	0.223 (1.442)	0.099 (0.709)
Macropolicy (Macro)	0.814 (2.198)	2.396 (4.231)	4.061 (5.519)	0.418 (1.283)	0.292 (1.040)
Technology		-1.169 (-2.682)	-2.621 (-5.032)		
Intensity of Internet				5.416 1.372	4.829 1.149
Intensity of Cellfone				3.751 5.761	3.316 4.479
Eastern region			3.7397 7.342		5.094 8.989
Western region			4.2681 8.497		5.594 9.233
Northern region			4.640 7.710		6.029 8.872
Southern region			5.426 9.843		5.8488 8.904
Explanatory power (Adj. R^2)	0.2126	0.2481	0.5428	0.4325	0.4975
Joint hypothesis test [F-statistic]	910.572 [4,42]	763.494 [5,41]	788.385 [8, 38]	845.306 [6 ,40]	637.352 [9, 37]
Goodness-of-fit (χ^2 [deg freedom]	8.2730 [4]	1.4699 [3]	4.3429 [4]	7.515 [2]	6.480 [1]
Predictive power (SEE/Mean)	0.1126	0.1100	0.0858	0.0956	0.0899
Durbin-Watson {ρ}	1.904 {0.015}	1.784 {0.068}	1.885 {0.026}	2.454 {-0.229}	2.3605 {-0.189}
Log likelihood function (LLF)	-54.9722	-53.3555	-40.1675	-46.3180	-41.727

[b] () are T-ratios at the 5% significance level; [] are degrees of freedom.

Figure 2 - Actual and estimated per capita real GDP across African countries
(for countries number codes see Appendix table)

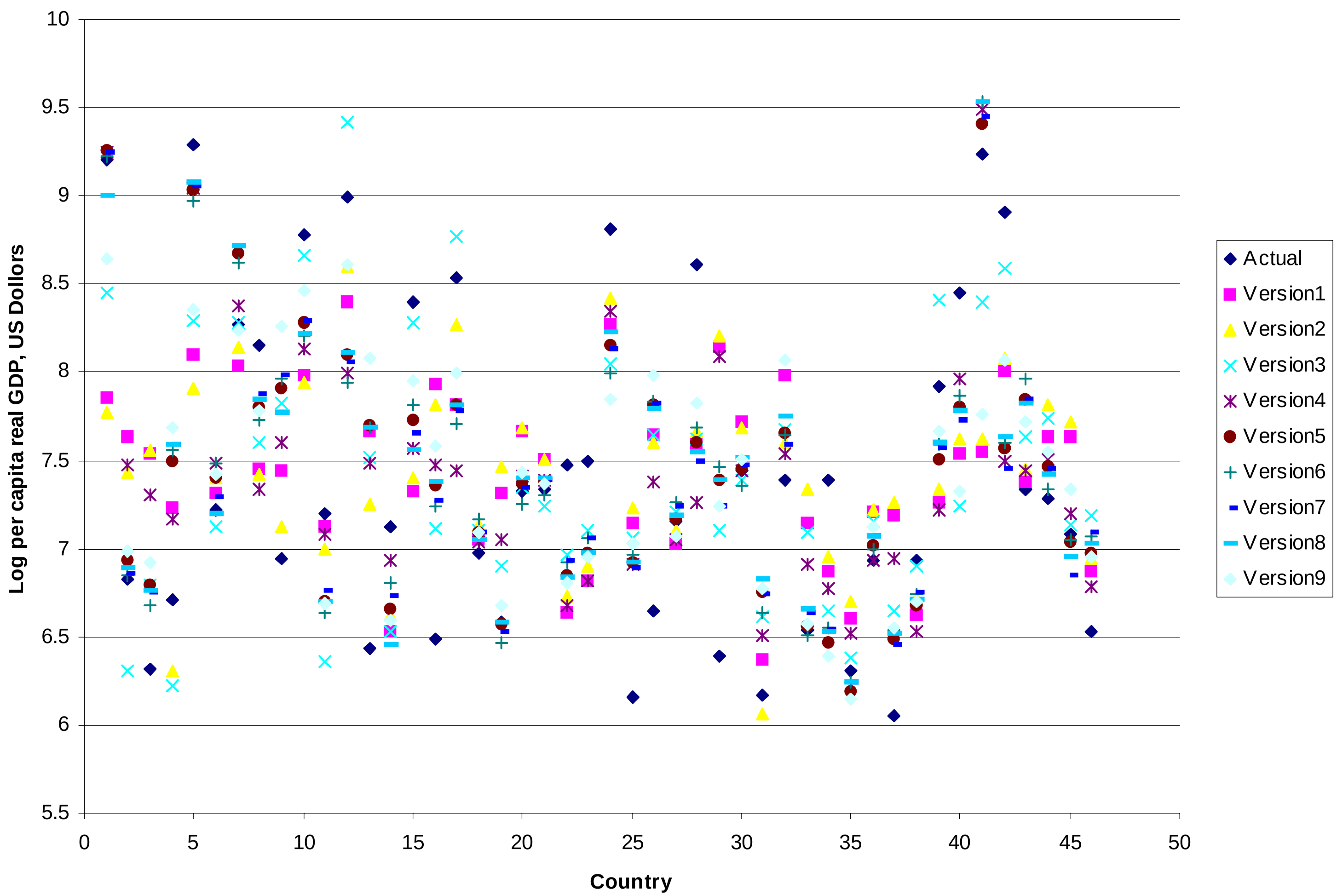


Table 3 - Determinants of per capita GDP across African countries, 2004/2005[c] - Auxiliary Versions

Variable	Version 6	Version 7	Version 8	Version 9
Constant	N/A	N/A	N/A	N/A
Log capital-labour ratio	0.406 2.354	0.406 2.155	0.398 2.011	0.342 1.752
Log Openness	0.076 0.538		0.067 0.462	0.207 1.476
Macropolicy (Macro)		0.246 0.864	0.337 1.209	0.512 1.661
Intensity of Internet	5.665 1.409	3.659 0.785		6.919 1.246
Intensity of Cellfone	3.470 4.378	3.460 4.631	3.395 4.408	
Eastern region	5.289 10.355	5.283 11.042	5.120 8.627	4.775 8.401
Western region	5.796 10.042	5.817 12.311	5.604 8.947	5.327 9.293
Northern region	6.282 9.129	6.264 9.853	6.006 8.093	5.818 8.108
Southern region	6.052 9.780	6.126 11.685	5.956 8.625	5.780 8.198
Explanatory power (Adj. R^2)	0.5005	0.5041	0.5017	0.3469
Joint hypothesis test [F-statistic]	721.322 [8,38]	726.464 [8,38]	722.937 [8,38]	550.494 [8, 38]
Goodness-of-fit (χ^2 [deg freedom])	5.061 [2]	6.271 [2]	3.004 [2]	3.8912 [2]
Predictive power (SEE/Mean)	0.0897	0.0894	0.0895	0.1025
Durbin-Watson {ρ}	2.473 {-0.249}	2.4131 {-0.221}	2.385 {-0.204}	1.8984 {0.040}
Log likelihood function (LLF)	-42.1994	-42.0370	-42.1483	-48.3689

[c] () are T-ratios at the 5% significance level; [] are degrees of freedom.

Figure 3b - Regional variations: Technology and GDP across African countries (Version 5)
(for country number codes see appendix table)

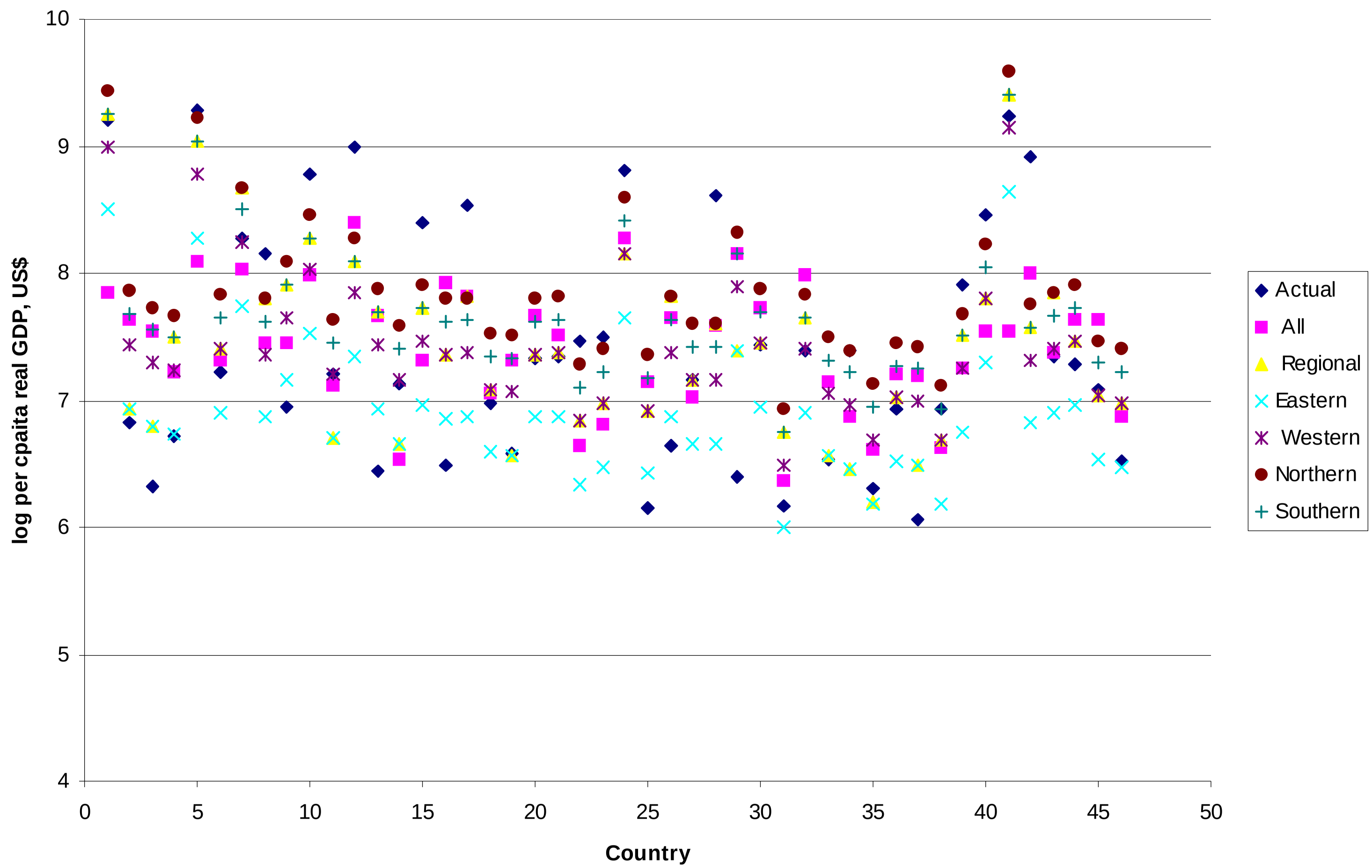


Figure 3a - Regional variations: technology and GDP across African countries (Version 3)
(for country number codes see appendix table)

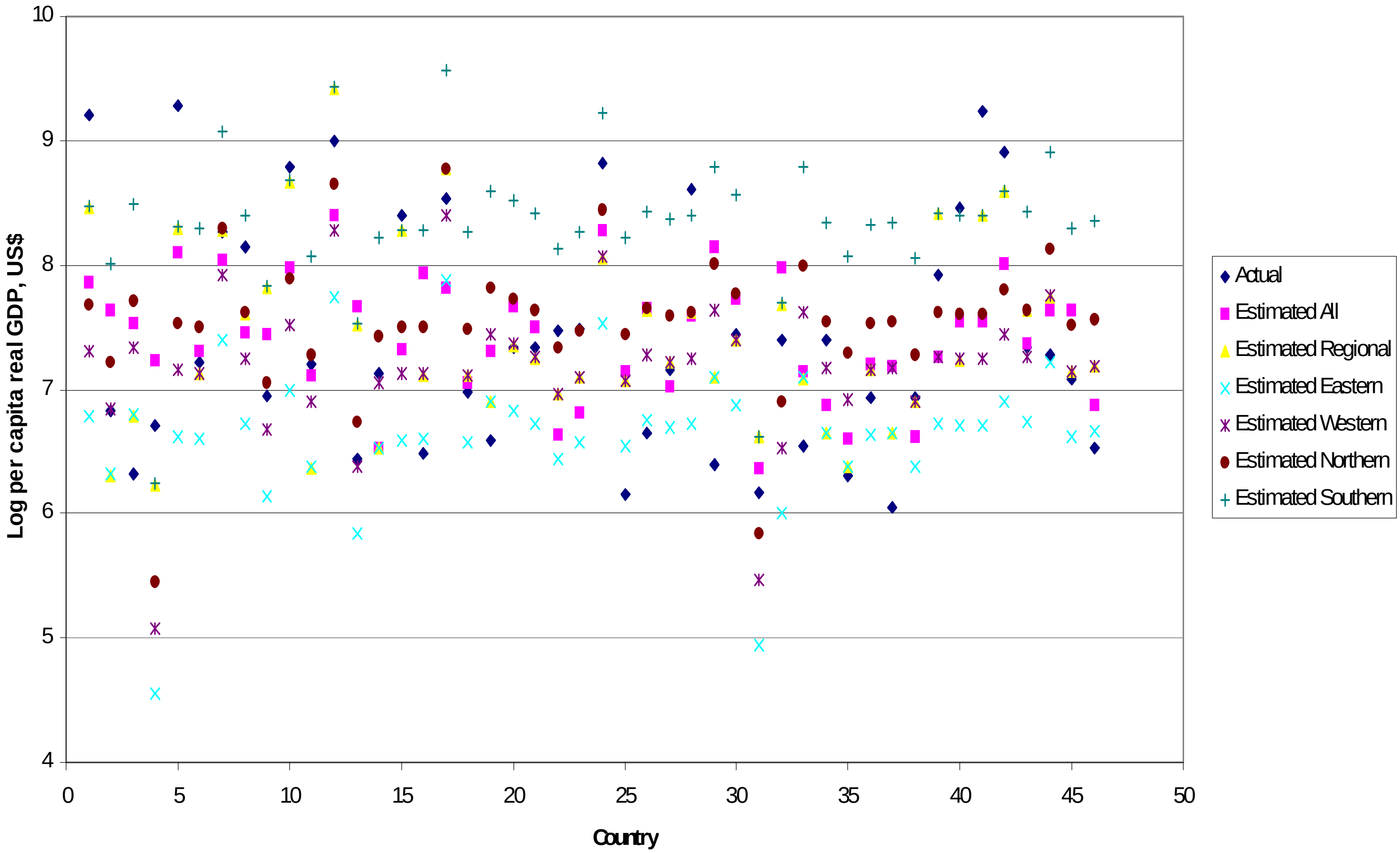
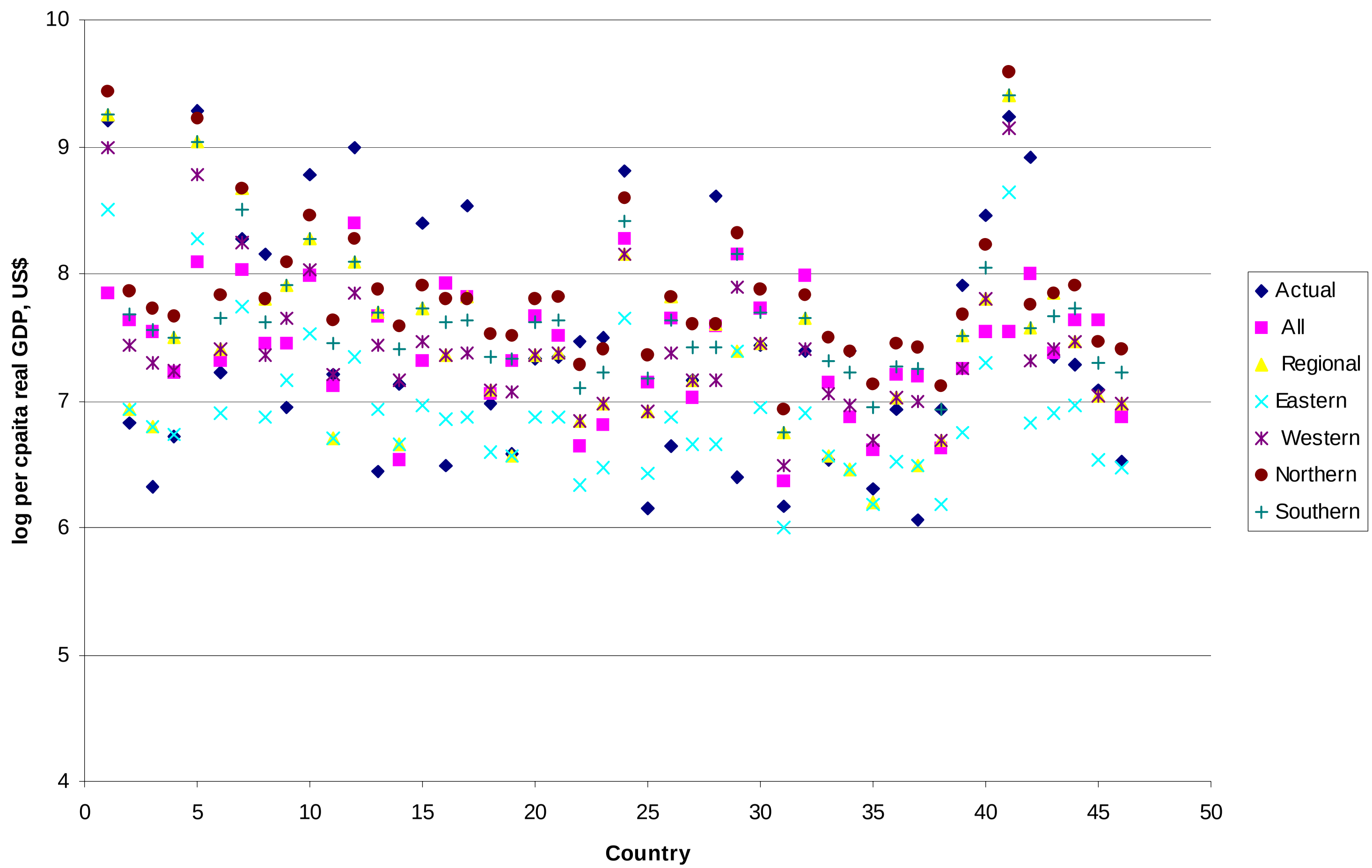


Figure 3b - Regional variations: Technology and GDP across African countries (Version 5)
(for country number codes see appendix table)



Appendix Table of Countries in this paper and raw data

Country	Code	GDPPC	Openness	K-formatioı	InflationRa	Internet	Cellfone	Landfone	Railways	Highways	DummyEa	DummyNo	DummyWe	DummySo	Macroecor	Tehnology
SouthAfric	1	10700	0.1486	15.88	7.44	0.093	0.379	0.109	0.005	0.1008	0	0	0	1	4.08	4.35
Kenya	2	1000	0.1745	13.44	7.6	0.021	0.048	0.01	0.0001	0.0019	1	0	0	0	3.12	3.36
Tanzania	3	600	0.1224	11.44	7.53	0.022	0.025	0.004	0.0001	0.0025	1	0	0	0	3.49	3.22
Zimbabwe	4	1900	0.1226	17.244	56.8	0.009	0.03	0.024	0.0002	0.0015	0	0	0	1	1.98	3.34
Mauritius	5	11400	0.289	20.14	5.58	0.027	0.372	0.28	0	0	0	0	0	1	3.66	4.1
Cote d'Ivoir	6	1400	0.3406	10.05	2.73	0.04	0.073	0.019	0.00003	0.003	0	0	1	0	1.78	1.23
Morocco	7	4000	0.1647	25.12	2.23	0.005	0.228	0.038	0.0001	0.0018	0	1	0	0	3.95	3.5
Egypt	8	3900	0.0792	12.33	11.076	0.001	0.076	0.115	0.0001	0.008	0	1	0	0	3.7	3.64
Mozambiq	9	1200	0.0845	25.086	13.83	0.065	0.022	0.004	0.0002	0.0016	0	0	0	1	2.57	2.84
Namibia	10	7100	0.1721	23.05	8.2	0.049	0.111	0.063	0.0012	0.033	0	0	0	1	3.75	3.72
Uganda	11	1400	0.0453	12.01	4.03	0.022	0.029	0.002	0.0001	0.001	1	0	0	0	3.2	3.25
Botswana	12	8800	0.2979	28.31	8.62	0.032	0.027	0.087	0.0005	0.0062	0	0	0	1	4.44	3.78
Zambia	13	800	0.2457	17.244	21.8	0.028	0.022	0.008	0.0002	0.0061	0	0	0	1	2.49	2.96
Rwanda	14	1300	0.0318	12.73	4.43	0.06	0.016	0	0	0.0015	1	0	0	0	1.78	1.23
Swaziland	15	4900	0.358	9.77	9.58	0.052	0.078	0.0407	0.0003	0	0	0	0	1	1.78	1.23
Nigeria	16	800	0.3612	14.23	18.15	0.002	0.025	0.007	0	0.0016	0	0	1	0	3.16	3.16
Benin	17	5900	0.1972	12.66	13.88	0.002	0.045	0.069	0.0001	0.0032	0	1	0	0	3.78	2.48
Benin	18	1100	0.1519	10.97	2.62	0.013	0.033	0.009	0.0001	0	0	0	1	0	1.78	1.23
Madagasc	19	800	0.1157	8.63	9.36	0.011	0.016	0.003	0	0.0029	1	0	0	0	3.1	2.47
Senegal	20	1600	0.1718	13.056	4.63	0.003	0.053	0.021	0.0001	0.0013	0	0	1	0	3.33	3.04
Cameroon	21	1800	0.1325	12.66	14.7	0.008	0.067	0.007	0.0001	0.0021	0	0	1	0	3.1	2.8
B.Faso	22	1100	0.0621	8.75	2.46	0.009	0.017	0.005	0	0.0009	0	0	1	0	1.78	1.23
Guinea	23	2100	0.0707	12.38	14.7	0.01	0.012	0.003	0.0001	0.0033	0	0	1	0	1.78	1.23
Tunisia	24	6900	0.2664	23.62	2.64	0.001	0.191	0.117	0.0002	0.0019	0	0	1	0	4.38	3.9
SierraLeon	25	500	0.2434	8.898	5.68	0.0001	0.011	0.004	0	0.0019	0	0	1	0	1.78	1.23
Mali	26	900	0.1712	19.938	14.7	0.008	0.021	0.005	0.0001	0.0013	0	1	0	0	2.67	2.36
Togo	27	1500	0.0955	16.1	14.7	0.004	0.04	0.011	0	0.0014	0	0	1	0	1.78	1.23
Libya	28	6400	0.5716	12.66	14.7	0.0004	0.018	0.133	0	0.0148	0	1	0	0	1.78	1.23
Congo, Re	29	700	0.9873	33.31	14.7	0.003	0.11	0	0.0003	0.0043	1	0	0	0	1.78	1.23
Ghana	30	2200	0.1288	20.441	22.44	0.002	0.039	0.015	0.0001	0.0019	0	0	1	0	3.29	3.1
Malawi	31	600	0.1274	-1.68	20.43	0	0.114	0.007	0.0001	0.0023	0	0	0	1	2.49	2.79
Angola	32	1900	0.6591	19.52	14.7	0	0.018	0.009	0.0003	0.0047	0	0	0	1	2.22	2.43
Ethiopia	33	700	0.0501	14.65	1.03	0	0.0013	0.006	0	0.0004	1	0	0	0	2.89	2.17
Sudan	34	1900	0.0641	15.65	14.7	0	0	0.023	0.0002	0.0003	1	0	0	0	1.78	1.23
Burundi	35	600	0.0674	7.42	8.62	0	0	0	0	0.0023	1	0	0	0	1.78	1.23
Chad	36	1200	0.0938	12.66	14.7	0	0	0	0	0.0027	0	0	1	0	2.5	2.06
Somalia	37	500	0.1895	12.66	14.7	0	0	0.012	0	0.0013	1	0	0	0	1.78	1.23
CAR	38	1200	0.0744	7.056	14.7	0	0	0	0	0.0064	0	0	1	0	1.78	1.23
Lesotho	39	3000	0.1833	15.97	8.7	0.006	0.0449	0.0142	0	0	0	0	0	1	1.78	1.23
Gabon	40	5500	0.5045	12.66	14.7	0.003	0.2097	0.0268	0.0033	0.0059	0	0	1	0	1.78	1.23
Reunion	41	12000	0.5107	12.66	14.7	0	0.6203	0.3799	0	0	0	0	0	1	1.78	1.23
Seychelles	42	7800	1.2128	18.56	5.1	0	0	0	0	0	0	0	0	1	1.78	1.23
Mauritania	43	1800	0.2596	15.448	14.7	0.0001	0.0939	0.01	0	0	0	1	0	0	1.78	1.23
Gambia	44	1700	0.1202	12.14	14.7	0.023	0.0606	0.0233	0	0	0	0	1	0	3.85	3.22
CapeVerde	45	1400	0.9716	8.53	14.7	0.0058	0	0.1701	0	0	0	0	1	0	1.78	1.23
Niger	46	800	0.0612	16.296	14.7	0.0001	0	0	0	0.001	0	0	1	0	1.78	1.23

NOTES

1. Data for this figure comes mainly from Rory J. Clarke's article available at http://www.oecdobserver.org/news/fullstory.php/aid/. I supplemented these data with other pieces from http://hdr.undp.org/reports/global, http://www.africafocus.org/docs06/econ0601.php, and http://www.worldfactsandfigures.com/gdp_country_desc.php.

2. The term "ethereal" I learned from Toynbee (1957), Chapters 11 and 12.

3. Both the Africa dummy and Africa TFP are not directly comparable because of different models and estimators. However, the negative signs of the coefficients have been revealingly consistent.

4. Among few exception Kwabena Gyimah-Brempong and Mark Wilson (2005) dispute the Africa differentness.

5. Land-based telephone, railway, and highway intensities were also considered but these were multicorrelated with each and correlated with capital-labour ratio.