WPS4914

Policy Research Working Paper 4914

Infrastructure and Growth in Africa

César Calderón

The World Bank
Africa Region
African Sustainable Development Front Office
April 2009

Policy Research Working Paper 4914

Abstract

The goal of the paper is to provide a comprehensive assessment of the impact of infrastructure development on growth in African countries. Based on econometric estimates for a sample of 136 countries from 1960–2005, the authors evaluate the impact on per capita growth of faster accumulation of infrastructure stocks and of enhancement in the quality of infrastructure services for 39 African countries in three key infrastructure sectors: telecommunications, electricity, and roads.

Using an econometric technique suitable for dynamic panel data models and likely endogenous regressors, the authors find that infrastructure stocks and service quality boost economic growth. The growth payoff of reaching the infrastructure development of the African leader (Mauritius) is 1.1 percent of GDP per year in North Africa and 2.3 percent in Sub-Saharan Africa, with most of the contribution coming from more, rather than better, infrastructure.

Across Africa, infrastructure contributed 99 basis points to per capita economic growth, versus 68 points for other structural policies. Most of the contribution came from increases in stocks (89 basis points), versus quality improvements (10 basis points).

The findings show that growth is positively affected by the volume of infrastructure stocks and the quality of infrastructure services; simulations show that our empirical findings are significant statistically and economically. Identifying areas of opportunity to generate productivity growth, the authors find that African countries are likely to gain more from larger stocks of infrastructure than from enhancements in the quality of existing infrastructure. The payoffs are largest for telephone density, electricity-generating capacity, road-network length, and road quality.

This paper—a product of the African Sustainable Development Front Office, Africa Region—is part of a larger effort in the region to gauge the status of public expenditure, investment needs, financing sources, and sector performance in the main infrastructure sectors for 24 African focus countries, including energy, information and communication technologies, irrigation, transport, and water and sanitation. Policy Research Working Papers are also posted on the Web at http://econ.worldbank.org. The author may be contacted at ccalderon@worldbank.org.

Infrastructure and Growth in Africa

César Calderón

Acknowledgments

This study is part of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. Financing for AICD is provided by a multi-donor trust fund to which the main contributors are the Department for International Development (United Kingdom), the Public Private Infrastructure Advisory Facility, Agence Française de Développement, and the European Commission. Inquiries concerning the availability of datasets should be directed to vfoster@worldbank.org.

The authors would like to thank the Public-Private Infrastructure Advisory Facility (PPIAF) for its financial support in constructing the data set on infrastructure stocks and quality measures. He would also like to thank Vivien Foster and Cecilia Briceño-Garmendia for very useful comments.

Contents

About the author

César Calderón is an economist in the World Bank's Office of the Chief Economist for Latin America and the Caribbean.

The empirical literature on growth identifies inadequate infrastructure provision aone of the main problems in Africa, along with poor education, political instability, and bad policies (Wheeler 1984, Hussain and Faruqee 1994). Easterly and Levine (1997) suggest that the ethnic diversity in Africa may explain bad policy decisions in the region and an inefficient provision of public goods (such as infrastructure).

The literature on development economics, on the other hand, has stressed the importance of infrastructure on productivity growth. The World Bank's 1994 World Development Report points out that productivity growth is higher in countries with an adequate and efficient supply of infrastructure services (World Bank 1994). The debate on the role of infrastructure in economic development has been reignited thanks to recent developments in policy circles. First, the increasing pressures of fiscal adjustment in most industrial and developing countries have called for public sector retrenchment and a decreasing participation in infrastructure. Second, the reduced participation of the public sector in infrastructure provision has opened infrastructure industries to the private sector. This reflects an increasing reliance on market mechanisms that has led to the privatization of public utilities, multiple concessions, and other forms of public–private partnership.

Infrastructure is a key element present in policy debates. Lederman, Maloney, and Servén (2005) have found that the efficient provision of infrastructure is crucial for the success of trade-liberalization strategies aimed at optimal resource allocation and export growth. Access to infrastructure services, on the other hand, has been found to play a significant role in helping reduce income inequality (Estache, Foster, and Wodon 2002; Calderón and Chong 2004; Calderón and Servén 2004a; Galiani and others 2005). As we said before, however, the needs for fiscal adjustment and consolidation in many countries have led to a reduction of public infrastructure spending that has not been offset by an increase in private investment. This has resulted in the insufficient provision of infrastructure (Blanchard and Giavazzi 2004; Easterly and Servén 2003).

The main objective of the present report is to provide a comprehensive assessment of the impact of infrastructure development on economic growth in African countries. Based on econometric estimates for a sample of 136 countries over the period 1960–2005, we evaluate the impact of a faster accumulation of infrastructure stocks and an enhancement in the quality of infrastructure services on economic growth across African countries over the 15-year study period. In the present report, we focus on three infrastructure sectors (telecommunications, electric power, and transportation), and, given the lack of monetary indicators for a large cross-country sample, we use physical indicators to measure not only the volume of infrastructure assets but also the quality of the services provided by these assets.

The rest of the report is organized as follows. Section 2 describes the measures of infrastructure quantity and quality used in the analysis, and discusses the econometric issues that arise when attempting to measure the impact of infrastructure. In section 3 we offer a brief overview of trends in infrastructure development in Africa relative to other regions across the world. Section 4 presents an empirical assessment as well as some simulations for African countries. Section 5 concludes.

1 Methodology

In order to evaluate the impact of infrastructure development on economic growth, we have gathered a large macroeconomic panel data set with information organized in five-year periods for 136 countries over 1960–2005.[1] Our panel data set is unbalanced since we do not have complete information for all countries over the sample period. To avoid biases introduced by countries with a very small number of observations, we restrict our sample to countries for which there are at least three consecutive time-series observations.

In the present section we tackle two main problems found in literature on the subject:

(a) Evaluating the impact of several types of infrastructure assets instead of the overall infrastructure sector, as well as including some measure of service quality

(b) Dealing with the likely endogeneity / reverse causality of infrastructure stocks as well as service quality

Measuring the quantity and quality of infrastructure

The empirical literature on infrastructure and economic performance has been plagued by an abundance of single-infrastructure-sector assessments. Although most of these papers take a broad theoretical view of infrastructure, they use indicators of a single-infrastructure sector for their empirical analysis. For instance, Easterly (2001) and Loayza, Fajnzylber, and Calderón (2005) use the measure of telephone penetration (main telephone lines per 1,000 people) as a proxy for infrastructure.

The use of single-sector analysis in the empirical assessment of the link between infrastructure and economic performance is mostly explained by the high degree of correlation among measures of infrastructure asset types (such as telecommunications, electricity-generating capacity, road and railway networks, and water and sanitation, among others). The high degree of comovement between the stock measures (and quality measures) of different infrastructure sectors may prevent us from identifying their estimated impact on economic growth.[2] To tackle this problem, we follow the strategy pursued in Calderón and Servén (2004a), and build an aggregate index that summarizes the stock of the different types of infrastructure assets and the indicators of service quality in different infrastructure sectors. These indicators are aggregated using the principal components analysis (PCA), and our aggregate (or synthetic index) is of the first principal components for the underlying variables.[3]

In order to construct our aggregate indices of infrastructure quantity and quality, we combine information on physical indicators in three infrastructure sectors: telecommunications, electricity, and

[1] Since our focus is on long-run trends in growth rather than its behavior over the business cycle, we work with data averaged over five-year periods to smooth out short-term fluctuations.

[2] For example, Calderón and Servén (2004a) found that when infrastructure indicators of telecommunications, power, and roads were included together in a growth-regression equation, the estimated coefficient of power was negative and not statistically significant, whereas either main lines or road networks were statistically insignificant in some regressions.

[3] Alesina and Perotti (1996) have used the principal components analysis (PCA) to create a measure of political instability, while Sanchez-Robles (1998) use this method to build an aggregate index of infrastructure stocks.

roads. We should point out that constructing these aggregate indices has some advantages. They may help:

(a) Reduce the measurement error associated with only taking a single-infrastructure indicator (for either quantity or quality) in the empirical analysis

(b) Solve the problem of high colinearity among the different types of infrastructure assets

In sum, aggregate indices of infrastructure stock and quality may help us reduce the dimensions of the problem and focus on synthetic (or aggregate) indicators.[4]

Principal components analysis (PCA)

Our synthetic indices of infrastructure stock and service quality are constructed using the PCA method. This takes *n* specific indicators and yields new indices (principal components) that capture information on the different dimensions of the data and that are mutually uncorrelated (Theil 1970).[5]

Our aggregate index of infrastructure is the first principal component of the vector of physical indicators of infrastructure stocks {K_1, K_2 and K_3} and infrastructure service quality {Q_1, Q_2, Q_3}. Generally speaking, the first principal component is defined by the vector of weights $a = (a_1, a_2, \ldots, a_n)'$ on the (standardized) set of (infrastructure quantity and quality) indicators $\{X_1, X_2, .., X_n\}$ such that the linear combination

$$P_1 = a_1X_1 + a_2X_2 + \ldots + a_nX_n$$

has the maximum variance for any possible choice of weights subject to restriction that the sum of squares normalization is equal to 1 (that is, $a'a = 1$). Using the PCA, we construct an aggregate index of infrastructure stocks and an aggregate index of infrastructure services (**IK** and **IQ**, respectively).

The aggregate index of infrastructure stock

We aggregate individual physical measures of infrastructure in telecommunications, electricity, and roads to compute our index of infrastructure stocks. In the telecommunications sector, our stock measure is either proxied by the number of main telephone lines and mobile phones per 1,000 workers (that is, telephone penetration) or simply the number of main lines per 1,000 workers. Electricity-generating capacity—measured in megawatts per 1,000 workers—is our proxy for the stock of infrastructure in the electricity sector. The size of the infrastructure stock in roads is captured by the length of the total road network (in kilometers) normalized by either arable land (square kilometers) or the surface area in the country. All variables are expressed in logs and the underlying data are described in more detail in Calderón and Servén (2004b).

We compute four different aggregate indices of infrastructure stocks with all the possible combinations of physical measures of infrastructure in telecommunications, electricity, and roads

[4] In addition, using the *a priori* coefficients of infrastructure assets (obtained from the PCA) we can estimate the impact of each single-infrastructure sector.

[5] In our work we standardize the indicators to have unit variance; equivalently, we base the principal components on the correlation matrix rather than the covariance matrix.

mentioned above. The index **IK**$_1$—the focus of our analysis—is the first principal component that comprises information on main lines and mobile phones per 1,000 workers, electricity-generating capacity (in megawatts per 1,000 workers), and length of total road network (in kilometers per square kilometer of arable land). The index **IK**$_2$ uses main telephone lines instead of the aggregate main lines and mobile phones used in the first index. On the other hand, the indices **IK**$_{1a}$ and **IK**$_{2a}$ use the length of total road network normalized by the surface area of the country relative to the aggregate indices previously mentioned above. Also, we observe not only that the weights are similar among aggregate indices, but also that these alternative global indices are highly correlated.[6] Table 1 presents the weights of the variables in the PCA.

Our preferred indicator, **IK**$_1$, is the first principal component of main telephone lines and mobile phones per 1,000 workers, electric power-generating capacity (in megawatts per 1,000 workers), and road network length (in kilometers per square kilometer of arable land), and accounts for almost 80 percent of their overall variance. As expected, **IK**$_1$ is highly correlated with each individual measure considered. Specifically, the correlation between **IK**$_1$ and main telephone lines and mobile phones is 0.94, its correlation with electricity-generating capacity is 0.96, and with the length of the road network it is 0.79. All three measures of infrastructure stocks enter the first principal components with approximately similar weights:

$$IK_1 = 0.603 * \ln\left(\frac{Z_1}{L}\right) + 0.613 * \ln\left(\frac{Z_2}{L}\right) + 0.510 * \ln\left(\frac{Z_3}{A}\right)$$

where **IK**$_1$ is the synthetic index of infrastructure stock, (Z_1/L) is the number of main telephone lines and mobile phones per 1,000 workers, (Z_2/L) is the electricity-generating capacity (megawatts per 1,000 workers), and (Z_3/A) represents the total road length normalized by the surface area of arable land in the country (in kilometers per square kilometer). Note that all variables are expressed in logs.

Finally, the choice of infrastructure indicators underlying the synthetic index is consistent with the literature on the output contribution of infrastructure, which has focused on power, transportation, and (especially) telecommunications.

The aggregate index of infrastructure quality

We similarly proceed to construct an aggregate index of infrastructure quality using the first principal component of three indicators of service quality in the areas of telecommunications, electricity, and roads.[7] We use the following variables to capture infrastructure quality: waiting time (in years) for the installation of main telephone lines (telecommunications), the percentage of transmission and distribution losses in the production of electricity, and the share of paved roads in total roads. We should point out

[6] The actual correlation among the global indices is over 0.98.

[7] An alternative approach to measuring the effectiveness of infrastructure capital is that of Hulten (1996). He sorts information on infrastructure effectiveness across the world by quartiles, inputting the highest values of 1 to the top quartile and 0.25 to the bottom quartile. He then averages the values assigned for each infrastructure sector. This procedure, however, entails loss of information as these indicators could show a wide degree of variation within the quartiles.

that all our indicators of infrastructure quality are rescaled to 0–1 in such a way that higher values indicate better quality of infrastructure services.[8]

Our aggregate index of infrastructure service quality, **IQ**, is the first principal component of these indicators of infrastructure quality. It captures approximately 60 percent of their total variation and it shows a high correlation with each of the three individual quality indicators: 0.81 for quality in telecommunications, 0.75 for electricity service quality, and 0.75 for road quality. Using the weights obtained with principal components, the synthetic index of infrastructure quality can be expressed as:

$$IQ = 0.608 * Q_1 + 0.559 * Q_2 + 0.564 * Q_3$$

where **IQ** represents the first principal component of our measures of infrastructure quality, Q_1 represents the measure of waiting time for installation of main lines, Q_2 the share of power output net of transmission and distribution losses in total output, and Q_3 the share of paved roads in total roads. Again, note that all the variables are rescaled to 0–1 and transformed in such a way that higher values indicate better infrastructure quality. Finally, the indicators of infrastructure quantity and quality share a good deal of common information—that is, the correlation between $\mathbf{IK}_1$ and **IQ** is 0.76. Across infrastructure sectors, the respective stocks and their quality measures are also positively correlated: 0.58 for telecommunications, 0.46 for electricity, and 0.59 for roads.

Econometric methodology[9]

We collect a pooled data set of cross-country and time-series observations for 136 countries (data details are given below), and use an estimation method that is suited to dynamic panel data. This methodology not only controls for unobserved time- and country-specific effects but also accounts for some endogeneity in the explanatory variables. This is the generalized method of moments (GMM) for dynamic models of panel data developed by Arellano and Bond (1991), and Arellano and Bover (1995). For more details on the econometric methodology, see appendix 1.

We run a regression on growth in real output per worker on a standard set of growth determinants, and on aggregate indices of infrastructure stock and infrastructure quality.

Our set of control variables comprises information on the level of human capital, financial depth, trade openness, institutional quality, lack of price stability, government burden, and terms-of-trade shocks.

Estimating our productivity growth-regression equation presents two potential problems: (a) the presence of unobserved effects, and (b) the presence of endogenous regressors. Unobserved time effects are dealt with by the inclusion of period-specific dummies, whereas unobserved country effects are

[8] The first of these three variables is admittedly not a direct indicator of the quality of telecommunications networks, but is significantly and positively correlated with the conceptually preferable measure (the number of telephone faults per 100 main lines), whose availability is severely limited in our sample. Over the available sample, the correlation coefficient is 0.3. Unfortunately, the coverage of unsuccessful local calls is extremely limited, with information available for only two to three selected years in the 1990s and a maximum cross-section coverage of 68 countries.

[9] This section draws from appendix II of Calderón and Servén (2004b).

handled by differencing and instrumentation. To control for joint endogeneity, the method again relies on instrumentation.[10] Specifically, it allows a relaxed assumption of the strong exogeneity of explanatory variables by allowing them to be correlated with current and previous realizations of the error term ξ. Since there are no obviously exogenous instruments available, we rely primarily on *internal instruments* in the spirit of Arellano and Bond (1991); that is, suitable lags of the explanatory variables.

In the case of infrastructure, we are concerned that moment conditions do not hold with the use of internal instruments and that our results may be driven by invalid instruments. It has been argued that future productivity shocks may encourage present infrastructure investment in the country. In this context, we are required to find instruments that can be considered exogenous and yet be correlated with remittances. In this regard, following Canning (1998), we consider the initial level (as well as lagged levels) of urban population, labor force, and population density in each country as instruments for the quantity and quality of infrastructure.

The consistency of our GMM estimator depends on the validity of the moment conditions specified above, which can be checked through two specification tests (Arellano and Bond 1991, Arellano and Bover 1995). First, the Sargan test of overidentifying restrictions tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process; failure to reject the null hypothesis that the conditions hold gives support to the model. The second is the serial correlation test of the error term, $\varepsilon_{i,t}$. In the GMM-system specification we test whether the differenced error term (that is, the residual of the regression in differences) shows second-order serial correlation. First-order serial correlation of the differenced error term is expected even if the original error term (in levels) is uncorrelated, unless the latter follows a random walk. Second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving-average process of order two or higher. This would render the proposed instruments invalid (and would call for higher-order lags to be used as instruments). Again, failure to reject the null lends support to the model.

2 Infrastructure trends in Africa

In the present section we describe the main trends in the provision and quality of infrastructure services in Africa in the 15-year study period. We focus on a sample of 36 African countries with largely available physical measures of infrastructure stock and quality. In order to put the region in context, we compare the evolution of infrastructure development in Africa (and its subregions) with the group of Western European economies, the East Asian “miracle” economies (EAP7), and South Asia (for more details on the sample see table A.1).[11] The sources of data for our infrastructure variables are presented in table A.2.

We will present evidence across the different African subregions, including:

---

[10] Note that variables such as terms-of-trade shocks are considered strictly exogenous in the present report.

[11] The group of seven East Asian miracle economies (EAP7) comprises Hong Kong (China), Indonesia, the Republic of Korea, Malaysia, Singapore, Taiwan, and Thailand.

- North Africa: Algeria, Egypt, Libya, Morocco, and Tunisia
- West Africa: Benin, Burkina Faso, Côte d'Ivoire, Ghana, Guinea, The Gambia, Guinea-Bissau, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, and Togo
- East Africa: Burundi, Kenya, Rwanda, Tanzania, and Uganda
- Southern Africa: Angola, Botswana, Madagascar, Mauritius, Malawi, South Africa, Zambia, and Zimbabwe
- Central Africa: Central African Republic, Cameroon, Republic of Congo, the Democratic Republic of Congo (formerly Zaire), Ethiopia, Gabon, Sudan, and Chad

Aggregate indices of infrastructure development

We present the evolution of aggregate indices of infrastructure stock—specifically, $\mathbf{IK}_1$ and $\mathbf{IK}_2$—and the aggregate index of infrastructure service quality across African regions relative to other geographical areas in the world over the 15-year study period. We show the median across different groups of countries.

We find a very large infrastructure gap in Africa and all its subregions with respect to Western Europe and the EAP7, and also find that this gap has increased slightly over the 15-year study period (figure 1, panels a and b). The best performer among African subregions is North Africa, which not only has the largest level of infrastructure stocks in the African region but is also the only region that, on average, shows an increase in infrastructure assets in 2001–5 relative to 1991–5. Southern African countries show the second-highest levels of infrastructure stocks, while Central Africa displays the smallest stocks of infrastructure in 2001–5. We should note, however, that the representative country in the North African region exhibits a larger aggregate stock of infrastructure assets than the representative country in South Asia.

The aggregate quality of infrastructure services in Africa—as approximated by the **IQ** index—also shows that Africa significantly lags the representative countries in Western Europe and the EAP7. On the other hand, we find that only North Africa and Central Africa have shown an improvement in infrastructure service quality over the 15-year study period. In 1991–5, the level of infrastructure quality in North Africa, Southern Africa, and West Africa was higher than that in South Asia. By 2001–5, only North Africa showed a higher level of infrastructure quality than South Asia (figure 3).

Telecommunications

Figure 2 depicts the evolution of (the regional median of) several telecommunications-capacity indicators for Africa over the 15-year study period. Figures 2a and 2b display the penetration of main telephone lines and mobile phones in the different regions. In our discussion of the aggregate stock of telecommunications we will focus on these variables.

By 1991–5, the representative country in the African region displayed an average of 10 main telephone lines per 1,000 workers. Across subregions, North Africa was the leader with approximately 133 main lines per 1,000 workers, Southern Africa showed approximately 23 main lines, and Central and

East Africa, respectively, had only 7 and 5 main lines per 1,000 workers. These figures are far from the ones of the representative county in Western Europe (1,096) and the EAP7 (796). We should note, however, that telecommunications is the fastest-growing infrastructure sector in the region. By 2001–5, the median African country had approximately 93 main lines and mobile phones per 1,000 workers (more than nine times the figure in 1991–5). Because of the fast development in telecommunications, the infrastructure gap in 2001–5 in that sector declined for most of the African subregions, although it still remains large. For instance, the ratio of main lines and mobile phones in North Africa relative to Western Europe went up from 0.12 in 1991–5 to 0.22 in 2001–5 (figure 2b). Note that the evolution is qualitatively similar when evaluating the penetration of telephone main lines.

Figure 2c shows the evolution of our measure of quality in the provision of telecommunication services—as measured by the inverse transformation of the waiting time for main telephone line installation (in years).[12] We observe that efficiency in telecommunication services is very high among EAP7 and industrial economies, and that African countries significantly lag in terms of telecommunications quality, although some subregions in Africa seem to outperform South Asia.

We should point out that, with the exception of West Africa, all subregions in Africa display an improvement in the quality of telecommunications services over the 15-year study period. Also, we should note that North Africa showed the fastest improvement in this area, followed by East Africa. Quality of telecommunications in the representative African nation represented approximately 22 percent of the quality levels in either Western Europe or the EAP7 in 1991–5, while it represented almost 35 percent in 2001–5. In the case of North Africa, the reduction of the quality gap has been faster: in 1991–95, quality in the representative North African country was approximately 15 percent of that in Western Europe or the EAP7. It represented almost 50 percent in the period 2001–5. On the other hand, almost all African subregions outperformed South Asia in quality of telecommunications services in 1991–5. By 2001–5, however, only North African and West African countries displayed better quality than the representative South Asian country.

Electricity

The evolution of indicators of quantity and quality of services provided by the electricity sector is depicted in figure 3. Again, we observe that the electricity-generating capacity of the representative country in the African region—as well as in Sub-Saharan Africa—has slightly improved over the 15-year study period (although it has deteriorated in Western, Central, and Southern African countries). On average, North Africa displays the largest electricity-generating capacity in the region (0.8 megawatts per 1,000 workers in 2001–5), while Central Africa displays the lowest electricity-generating capacity (0.025 megawatts). Finally, we should point out that North Africa is the only subregion that outperforms South Asia in terms of electricity-generating capacity (figure 3a).

Figure 3b shows the evolution of the quality of infrastructure services in electricity as measured by transmission and distribution losses as a share of electricity production. We transform our variable in an analogous fashion to the indicator of telecommunications service quality, such that it takes values

[12] If we denote by *x* the number of years it takes to install a telephone line, our quality indicator is computed as $1/(1+x)$. Hence, our transformation takes values between 0 and 1, with higher values indicating improved quality.

between 0 and 1. Higher values of this measure would indicate higher quality of electricity services (and thus fewer technical losses in the provision of electricity). We observe a general decline in Africa and all its subregions in quality of electricity services over the 15-year study period—although the gap with respect to other regions is smaller. By 2001–5, technical losses represented approximately 14 percent of total electricity production in Africa. In the same period, technical losses were around 6 percent in Western Europe and East Asia (see figure 3.2). Southern Africa and North Africa register the best performance in the quality of the electricity sector—with technical losses of electricity production that averaged approximately 9 percent and 13 percent, respectively, in 2001–5.

Roads

The evolution (of the regional medians) of road stocks, as measured by the length and quality of total road network—captured by the share of paved in total roads—is presented in figure 4. Over the 15-year study period we observed very little progress in road stocks (either normalized by arable land or surface area).

Figure 4a depicts the length of the road network in kilometers per square kilometers of arable land. Over the 15-year study period, the length of the road network has remained almost unchanged, with the exception of the Southern African region (where it increased only 10 percent). On the other hand, we should point out that the infrastructure gap in roads relative to the median in the EAP7 and Western Europe has widened over the 15-year study period. Both regions have experienced an expansion of 60 and 16 percent in their road network, respectively (figures 4, panels a and b).

Finally, we present in figure 4c our measure of road network quality. Following Canning (1998) and Easterly and Servén (2003) we use the share of paved roads in total roads as our measure of transportation infrastructure quality. Africa (across its subregions) has a large gap in road quality with respect to Western Europe and the EAP7, and that gap has increased slightly over the 15 years in question—the percentage of paved roads declined from 17 percent in 1991–5 to 16 percent in 2001–5 in Africa. North Africa has a higher than average share of paved roads (66 percent in 2001–5), while East Africa and Central Africa display the lowest share of paved roads (approximately 7 percent in 2001–5).

3 Infrastructure and productivity growth in African countries

Our strategy carries out the estimation of an infrastructure-augmented productivity growth equation. We include a standard set of (noninfrastructure) determinants of growth per capita following Loayza, Fajnzylber, and Calderón (2005):

(a) The initial value of the real output per capita (in logs) to capture any transitional convergence effect.

(b) Structural factors and policies such as human capital (proxied by the gross enrollment rate in secondary schooling), financial depth (measured as domestic credit to the private sector as percentage of the gross domestic product, GDP), trade openness (real value of exports and imports as percentage of GDP), and governance (International Country Risk Guide, ICRG, index of institutional quality).

(c) Stabilization policies proxied by the lack of price stability (average inflation rate) and the size of government burden (as captured by the general government's real consumption as a percentage of GDP).

(d) External factors approximated by terms-of-trade shocks and time dummies that capture other global shocks.

In addition to this set of determinants, we include our variable of interest: *infrastructure development*. This dimension is captured by our aggregate indices of infrastructure stock and quality, as previously described.

Our empirical evaluation uses an unbalanced panel data set of five-year period observations over 1960–2005, with 580 observations in total. Before discussing our regression results, we should note that the correlation between economic growth and our aggregate index of infrastructure stock is equal to 0.22. The correlation between growth in output per capita and individual stocks is also positive (0.17 for main telephone lines, 0.13 for electric-power-generating capacity, and 0.27 for the total length of the road network). In addition, growth in output per worker is also positively correlated with the aggregate index of infrastructure quality—the degree of association is 0.32. The individual components of the quality index also have a positive association with growth in output per worker: 0.22 for telecommunications quality, 0.18 for energy provision, and 0.23 for road quality.

Regression analysis

We ran growth regressions augmented by aggregate indices of infrastructure stock and infrastructure service quality, and the results are reported in table 2. We used the GMM-IV system estimator proposed by Arellano and Bover (1995), and Blundell and Bond (1998). This tackles problems of unobserved time and country effects and, likely, endogeneity. Note that we used *external* instruments for infrastructure to avoid getting inconsistent estimates for our parameters of interest. Before we discuss the results obtained in table 2 we should point out that the specification tests (Sargan test and second-order correlation test) validate our moment conditions so that we can use our regressions for statistical inference.

Our coefficient estimates in table 2 suggest that: (a) there is evidence on conditional convergence for the real output per worker; (b) economic growth is enhanced by a faster accumulation of human capital, deeper financial systems, higher institutional quality, and favorable terms-of-trade shocks; and (c) growth is adversely affected by higher inflation and heavier government burden. We should also note that trade openness does not show a robust relationship to growth.

Regarding *infrastructure development*, we find that the aggregate index of infrastructure and the quality of infrastructure services have a positive and robust relationship to growth per capita. The relationship between growth and infrastructure stock is positive and robust to changes in the aggregate index used (see the results in columns [$\mathbf{IK}_1$] through [$\mathbf{IK}_{2a}$]). The estimated coefficient of the aggregate infrastructure stock is positive and significant, regardless of the aggregate index of infrastructure stock used. Thus, our results suggest a positive contribution of infrastructure development to productivity growth. We can provide the economic importance of the effect of infrastructure development on growth by using the coefficient estimates in column [$\mathbf{IK}_1$] of table 2.

First, let us evaluate the impact of higher infrastructure development across Africa and its subregions in 2001–5 relative to 1991–5. Over that period, the aggregate index of infrastructure stock and quality for the average African country grew by 67 percent and 10 percent, respectively. This resulted in an increase in the rate of growth of the economy of 99 basis points per year (89 basis points due to faster accumulation of infrastructure assets and 10 basis points due to higher quality of infrastructure services).

Of the African subregions, Central Africa has reaped the largest benefits in growth per capita from infrastructure development over the 15-year study period (using the $\mathbf{IK}_1$ aggregate index of infrastructure). Specifically, infrastructure development may have generated an increase in the rate of per capita growth of the representative country of 1.08 percent—of which 0.96 percent is due to a faster accumulation of infrastructure stocks and 13 basis points are due to improved infrastructure quality. Infrastructure development in Southern Africa comes second, with an average growth increase of 1.01 percent due to infrastructure in 2001–5 relative to 1991–5. Again, larger infrastructure stocks explain the bulk of the growth increase (85 basis points versus 16 basis points attributed to improved infrastructure service quality). Finally, we should point out that the lowest growth performance due to infrastructure development over the 15-year study period was achieved by West Africa. The growth per capita in West Africa increased by 88 basis points thanks to improvement in infrastructure over the 15-year period, despite a deterioration in the quality of infrastructure services.

At the country level, infrastructure development led to faster growth in Benin (1.63 percent), Botswana (1.66 percent), Egypt (1.51 percent), Mauritius (1.67 percent), Sudan (1.76 percent), and Uganda (1.54 percent). For most of these countries, the growth improvement is mostly attributed to a faster accumulation of infrastructure assets (which explains more than 80 percent of the growth increase attributed to infrastructure), and especially by a sharp increase in telephone main lines and mobile phone penetration. On the other hand, the contribution of higher stocks and sharp improvements in quality of services is more balanced in the case of Egypt.

In what follows, we will use our coefficient estimates to: (a) evaluate the consequences of changes in infrastructure development in 2001–5 relative to 1991–5 for African countries, and (b) assess the potential growth benefits for African countries of reaching the level of infrastructure development of a determined benchmark. In the next section we will explain, in detail, the mechanics of these two comparative exercises.

Growth payoff from infrastructure development in 2001–5 relative to 1991–5

Section 3 presented the evolution of aggregate as well as individual physical measures of infrastructure stocks and infrastructure quality for a large sample of countries and regions in the world. There we presented the evolution of infrastructure development from 1991–5 to 2001–5. In the present section, we aim to evaluate the growth consequences of the evolution of infrastructure development in this 15-year period.

Our analysis will consist of the two following dimensions: (a) we will assess the importance of infrastructure development in explaining the growth of the African continent (across its subregions) compared to the role played by other structural factors and stabilization policies, and (b) we will assess the contribution of the different types of infrastructure stocks across African subregions and countries over the 15-year study period.

We conduct this analysis using both the [$\mathbf{IK}_1$] and [$\mathbf{IK}_{2a}$] aggregate indices of infrastructure stocks. Our results using our preferred aggregate index of infrastructure stocks, [$\mathbf{IK}_1$], are presented in tables 2 and 4 as well as figures 5 and 6. Note that the results for the other indices are presented (see table 5 and table A.3 in the appendix), although they are not discussed in the document. We should note that the results with these alternative indices are qualitatively similar to those presented with our preferred index [$\mathbf{IK}_1$].

Infrastructure and other sources of growth in Africa

We perform an analysis of the sources of growth and we group the different determinants in the policy categories mentioned at the beginning of section 4. Although infrastructure development clearly belongs to the group of structural factors and policies, we consider it as a category by itself for the purposes of our analysis. In figure 5, we show the contribution of policy variables to growth in Africa (its subregions), as well as other regions in the world over the 15-year study period. Table 3 displays all the relevant information on the growth decomposition over time. We find that the model successfully predicts the changes in the growth of real output per capita in Western Europe, and does a fairly good job predicting changes in growth in some African subregions.

When we observe the results in table 3, we find that the contribution of infrastructure development to predicted growth is quite important in Western Europe and the EAP7. Infrastructure development contributes 99 basis points out of 1.1 percent predicted growth in the African region, while other structural policies contribute 68 basis points (mostly explained by improvements in education). Across subregions, the model predicts an increase in growth in Central Africa of 2.1 percent, with infrastructure development contributing with 1.08 percent (0.96 percent due to larger stocks and 0.13 percent due to improved quality). For Southern Africa, predicted growth increase in 2001–5 relative to 1991–5 was 1.2 (versus an actual growth increase of 2.2), and infrastructure development predicted an increase in growth of 1.01 percent (mostly attributed to higher stocks, which accounted for 0.85 percent), while other structural policies predicted an increase in growth of 0.55 percent.

Interestingly, West Africa is the only subregion where the contribution of other structural policies to growth (1.12 percent) is higher than the contribution of infrastructure development (0.88 percent) over the 15-year period. We should also point out that West Africa is the region with the smallest growth contribution due to infrastructure development. Among other structural policies, we find that the largest contribution to growth comes from improvements in education and institutional quality.

The contribution of infrastructure assets to growth in Africa

We now decompose the contribution to growth of infrastructure development by infrastructure asset types. Figure 6 shows the contribution to economic growth in Africa of the different measures of infrastructure stock and quality in telecommunications, electricity, and roads sectors over the 15-year study period. For more detailed results, see table 4.

We find that larger infrastructure stocks contributed to an increase in growth in the representative African country by 89 basis points per year, while improvements in the quality of infrastructure services explain only 10 basis points. Furthermore, if we take a closer look at the contribution of each infrastructure asset, we find that most of the increase attributed to larger stocks is due to advances in the penetration of telecommunications in the African region (94 basis points), while better quality in telecommunication services explains the bulk of growth enhancement due to higher quality in infrastructure (12 basis points). Also, we find that the representative country in the region has experienced deterioration not only in the stock but also in the quality of the electric power sector over the 15-year period.

Higher telephone penetration and improved quality of telecommunication services explain most of the contribution of infrastructure development to growth across the African subregions (figure 6, panel a). Interestingly, we find that while higher electricity-generating capacity may have contributed positively (also in smaller magnitude) to growth in North Africa and East Africa (on average), it has deteriorated and implied a negative growth contribution for the representative country in West Africa, Central Africa, and Southern Africa. Finally, an expansion in the road system has contributed significantly in Southern Africa, while increases in road quality (share of paved in total roads) has played some role in North Africa.

Figure 6b shows the contribution of different infrastructure assets to growth in North African countries. In general, telephone penetration, quality of telecommunication services, and road quality explain the largest bulk of the contribution of infrastructure development to growth in these countries. We also find that in most North African countries, quality of electricity provision has deteriorated and hindered growth, while a larger capacity to generate electricity contributed positively and significantly in Morocco and Tunisia. Finally, note that the largest contribution of infrastructure development to growth was attained by Egypt (1.51 percent) and Morocco (1.31 percent), while the smallest contribution was achieved by Algeria (31 basis points).

The contribution of infrastructure development among the Economic Community of West African States (ECOWAS) ranged between 0.15 percent (Togo) and 1.63 percent (Benin). The small growth contribution in Togo took place in spite of the deterioration in the electricity sector (both stock and quality of services), while growth enhancement in Benin is mostly attributed to improvement in telephone penetration and service quality, as well as an enlarged electricity-generating capacity (figure 6, panel c). On the other hand, while Tanzania and Uganda showed a positive contribution of infrastructure development to growth, a decrease in infrastructure development may explain the negative contribution of infrastructure development in Kenya. Note that the deterioration in the quality of electricity provision and roads may help explain the fall in growth due to infrastructure development. The drivers of the contribution of infrastructure to growth in Tanzania are the quantity and quality of its telecommunications sector and its larger electricity-generating capacity (figure 6, panel d).

For countries in the Southern African region, the contribution of infrastructure development to economic growth is very heterogeneous and fluctuates from -0.3 percent (Democratic Republic of Congo) to 0.6 percent (Mauritius). Note that the deterioration in infrastructure stocks—especially lower telephone penetration and a decline in electricity-generating capacity—help explain the decline in growth due to infrastructure development. In contrast, the growth enhancement in Mauritius due to infrastructure development is attributed to larger telephone penetration and improved quality of telecommunication services, as well as a larger electricity-generating capacity. In the case of Botswana, growth attributed to infrastructure development (0.4 percent) increased mostly due to the growth of telecommunication services (quantity and quality) and improved road network (figure 6, panel e).

Finally, Sudan has the largest contribution of infrastructure development on growth in the 15-year study period (0.7 percent), mostly due to a substantial increase in telephone penetration and better-quality electricity provision (including less technical losses). On the other hand, infrastructure explains a decline in growth in Congo and Gabon. The largest decline is experienced in Congo (–0.4 percent), which is explained by a decline in telephone penetration and higher losses in the transmission and distribution of electricity (figure 6, panel f).

The results using the [$\mathbf{IK}_4$] aggregate index—despite including mobile phones in the telecommunications indicator and using length of paved roads rather than total roads—did not change the qualitative nature of the results discussed above. One of the features that we may point out is the increasing dynamism in the mobile phone industry that sparked a boom in the telecommunications sector throughout the world. We can notice the increasing role of telecommunications (thanks to mobile phone services) in explaining growth changes in Africa. For more details on the results with the [$\mathbf{IK}_4$] aggregate index, see tables 5 and 6 and figures 7 and 8.

Potential growth payoff from infrastructure development among African countries

The next dimension of our analysis aims to use the coefficient estimates in table 2 to calculate the potential increase in economic growth, if the growth determinants of African countries were to be raised to the levels of selected benchmark countries or regions. Following Calderón and Servén (2004a), and Loayza and others (2005) we undertake this analysis at two levels:

We decompose growth by its potential sources of growth and present a potential growth surge attributed to an improvement in policy determinants of growth. This information helps us assess the economic importance of infrastructure development as a potential area of opportunity in Africa vis-à-vis other policy determinants of economic growth.

We decompose the potential growth payoff due to infrastructure development into the individual contribution of each infrastructure sector (both in terms of improved quantity and quality). Again, this analysis helps us identify the infrastructure sectors where the country is lagging (relative to some selected benchmark) and, hence, might render higher potential growth benefits.

Before calculating the potential productivity growth payoff of infrastructure development (as well as the payoff from other structural and/or stabilization policies), we need to define the benchmark countries. In what follows, we will describe the benchmark used and describe the values of this benchmark in terms of our variable of interest, the level of infrastructure development:[13]

[13] Note that the results presented on productivity growth enhancement in the subsequent tables and figures assume that the benchmark for other structural factors, stabilization policies, and level of output per worker need not be similar to the benchmark in infrastructure development.

(a) The leader in the African region (Mauritius)[14]

(b) The EAP7 representative country (Korea in stocks and Hong Kong in quality)

(c) The South Asian leader (India in stocks and Bangladesh in quality)

(d) The representative country among Western European economies (Great Britain)

We need to remark that in order to compute these scenarios we use the average values of the Economic Commission for Africa (ECA) countries, our benchmark countries for the period 2001–5, and the coefficient estimates in column [$\mathbf{IK}_1$] of table 2. Note that we also present here tables and figures with the calculations using the coefficient estimates in column [$\mathbf{IK}_4$] of table 2. Finally, we should point out that these catch-up scenarios implicitly assume potentially large investment efforts in the transition toward the increased levels of infrastructure development.

Scenario 1: Growth payoffs of reaching the leader in the African region

Table 7 reports the potential gains in the rate of growth of the economy for the African region, as well as its different subregions if the growth fundamentals were to be raised to the levels of the leader in the region (panel I of table 7). If so, the actual growth rate of the average African continent would rise by 7.29 percent, while the model predicts an increase in the growth rate of 4.58 percent. Note that improvements in structural policies (education, financial development, and institutional quality) help explain an increase in the growth rate of the average African country of 4.71 percent, while infrastructure development explains a 2.26 percent surge in growth (1.77 percent could be attributed to larger stocks and 0.49 percent may be due to improved stocks). The region that shows the largest potential increase in the growth rate under this scenario is Central Africa—which is also the region that, on average, is the farthest from the African leader in most policy areas (see figure 9, scenario 1). The potential growth increase in Central Africa is 5.7 percent, with 2.8 percent being attributed to infrastructure development (2.2 percent to higher stocks, and 0.6 percent to improved quality).

In what follows we analyze the potential growth benefits across African nations of reaching the leader of the region in infrastructure (Mauritius), and break down the potential benefits of infrastructure into the different sectors: telecommunications, electricity, and roads (see table 8). By construction, the countries that are closer to the leader (or the benchmark, generally speaking) will show the smallest infrastructure gap and will, therefore, have the smallest growth benefits. In this case, South Africa, Egypt, and Tunisia show the smallest gap in infrastructure development (stocks and quality of infrastructure) with respect to Mauritius, and the potential growth gain for these countries is less than 1 percent per year. Note that, in all cases, most of the growth gains would be attributed to faster accumulation of infrastructure assets—and

[14] Using the [IK_1] index of aggregate infrastructure stocks we note that Mauritius has the highest values for the aggregate index of infrastructure stock (1.02) and the aggregate index of the quality of infrastructure services (0.73). In terms of infrastructure, it represents approximately 61 telephone main lines per 1,000 workers, 1.2 megawatts of electricity-generating capacity per 1,000 workers, and 0.98 kilometers per square kilometer of surface area in roads. Quality would be measured by waiting time of main line installation of less than 4 months, electricity transmission and distribution losses of less than 10 percent of electric output, and a share of paved roads in the total road network higher than 90 percent.

specifically an enlargement of the road network. We should also remark that, in the case of South Africa, there is room for improvement in the quality of the provision of electricity.

On the other hand, several countries show a very large gap in infrastructure development with respect to Mauritius, the leader. These include Ethiopia, the Democratic Republic of Congo (formerly Zaire), the Central African Republic, the Republic of Congo, Chad, and Niger. Growth gains for all these countries are at least 3 percent per year—with 2.5–3 percent per year attributed to an enlargement of infrastructure stocks. For Chad and Niger, the size of the gap is almost uniformly distributed across infrastructure assets. That is, potential growth due to larger stocks is around 3 percent (of a 3.5 percent total increase due to infrastructure development), which is distributed almost uniformly (approximately 1 percent per year) across telecommunications, electricity, and roads. In the cases of Ethiopia and Congo, the largest gaps in infrastructure network are observed in electricity generation and telecommunications, respectively.

Finally, if we were to identify the infrastructure sector with the highest potential growth benefits across subregions, we find the following: (a) lengthening the road network seems to be a driving growth force in North Africa, (b) increasing electricity-generating capacity and telephone penetration is crucial for West Africa, (c) increasing infrastructure stocks in all three sectors may lead to a growth per capita increase of at least 2 percentage points in East African countries, (d) an analogous result holds for countries in the Southern African region with the exception of Mauritius and South Africa, and (d) improvements in the stocks of telecommunications and electricity seem key for Central African countries. For more details see figure 10.

Scenario 2: Growth payoffs of reaching the representative country among the EAP7

Figure 9 (panel b) depicts the potential growth increase if growth fundamentals across African subregions were to catch up with the representative EAP7 country. We observe that the largest gaps between the EAP7 and African subregions are in structural policies and infrastructure development. The gap in structural policies, augmented by infrastructure development, renders potential growth gains of at least 5 percent per year (with the exception of North Africa, with less than 3 percent). The potential contribution of infrastructure development to growth across African subregions ranges from 1.5 percent per year in North Africa to almost 3 percent in East Africa and Central Africa (figure 11, panel a). Most of the potential increase in growth per capita, as we can observe, can be attributed to the substantial gap in infrastructure stocks, especially in the telecommunications and electricity sectors.

In this scenario, the leader of the African region, Mauritius, still has room to improve in infrastructure development relative to the EAP7 median (Korea in infrastructure stocks and Hong Kong in quality of infrastructure services). Its growth rate would be raised by 37 basis points per year (25 basis points due to the gap in infrastructure stocks and 12 points due to improved service quality). The growth rate of South Africa would be raised by 97 basis points in this scenario, with the gap in infrastructure stocks contributing with 58 basis points, while 39 basis points may be explained by improved quality. On the other end of distribution, the growth rate would increase more than 3.5 percent per year in the Republic of

Congo, Chad, and Niger in this scenario. The gap in infrastructure stocks may contribute to a potential growth of 2.5–3.3 percent per year due to infrastructure development.

For North African countries, the contribution of infrastructure stocks to potential growth—if they were to reach the EAP7 median—is at least 1 percent per year, with the largest potential payoff coming from the road network (figure 11, panel b). In the West African countries, increasing telephone penetration and electricity-generating capacity may contribute at least 1.5 percent (except for Côte d'Ivoire and Ghana), with improvements in the road network also of important in some of these countries (figure 11, panel c). Higher infrastructure stocks may potentially generate an increase in the growth rate of 2 percent per year in the East African countries—with telephone penetration and electricity generation explaining more than two-thirds of this surge (figure 11, panel d). With the exception of Mauritius and South Africa (the leaders in infrastructure development in Africa), the contribution of higher infrastructure stocks to the growth rate among Southern African countries is at least 1.5 percent per year, and there is a significant payoff from improving road quality (figure 11, panel e). Finally, the payoff from infrastructure development in Central Africa ranges from 2.5 percent per year (Gabon) to almost 4 percent (Chad). The largest potential growth payoffs come from improving infrastructure stocks (especially telephone penetration) and improving road quality.

Scenario 3: Growth payoffs of reaching the leader in South Asia

Potential growth payoffs from improving growth fundamentals across African subregions if they catch up with the leader of South Asia are presented in figure 9 (panel c). As we can observe, the payoff from faster infrastructure development is less than 1 percent for North Africa (0.28) and South Africa (0.89); interestingly, there is no payoff from other structural factors for Northern African countries. Note that the largest potential payoff from improvements in all policy areas is 6.3 percent per year (East Africa), while the largest payoff from infrastructure development may be attained under this scenario by Central Africa (1.96 percent). Note that there is no payoff from telephone penetration and electricity (quantity and quality) for North Africa under this scenario and most of the growth payoff comes from the road network (figure 12, panel a). The same holds for Southern Africa, where the contribution of electricity and telecommunications is very small. For the rest of the subregions, improving stocks in all areas of infrastructure seem to reward most of the growth payoff, although improving road quality and electricity provision seem to generate some growth benefits.

Under this scenario, the leaders of the region seem to have no positive growth payoff due to the fact that they are better off than the leader in South Asia (see table 10). The same can be said of Egypt (where growth increases only by 1 basis point per year). The worst performers in infrastructure development in the region (Chad and Niger) would experience an increase in growth per capita of 2.7 percent—with 2.4 percent explained by faster accumulation of infrastructure assets.

We should note that there is no growth payoff from more telephone main lines per capita, electricity-generating capacity, and road quality for North African countries under this scenario (figure 12, panel b). Most of the growth payoff for these countries may come from a larger road network. For West African countries, the largest payoffs come from improving stocks in telecommunications, electricity, and roads, while the payoff from improving telecommunications quality is almost negligible for some countries (figure 12, panel c). East African countries have positive growth payoff from every infrastructure sector, with the exception of quality in telecommunication services (figure 12, panel d). For Southern African countries (other than Mauritius and South Africa), the largest growth payoff comes from enlarging the road network (figure 12, panel e). Finally, improving infrastructure stocks in roads, electricity, and telecommunications has a big payoff for most Central African countries. In terms of quality, improving road quality always renders positive payoff (figure 12, panel f).

Scenario 4: Growth payoffs from reaching the representative country in Western Europe

On average, our model predicts an increase in the growth rate of 4.1 percent for African countries if they were to reach the level of growth fundamentals exhibited by the representative country in Western Europe (see table 7). We should note that most of the growth increase is predicted by improvement in structural policies and infrastructure development. In figure 9 (panel d), we present the potential contribution of these policy areas for the African subregions. The leaders of the region—Mauritius and South Africa—would increase their growth rates by 0.6 and 1.2 percent per year under this scenario, with most of the payoff coming from the electricity sector for Mauritius and from the telecommunications sector for South Africa.

When compared to the median country in Western Europe, we find that the potential increase in growth fluctuates from 1.7 percent per year (North Africa) to 3.4 percent (Central Africa). Enlarging the road network and improving its quality seems to have the largest payoff in North Africa, while improvements in telephone penetration and electricity-generating capacity seem to drive the growth payoff in the other regions (figure 13, panel a). Note that the payoff from improved infrastructure quality is larger. It ranges from 0.5 percent per year in North Africa to 0.8 percent in East Africa and Central Africa. Most of the payoff from improving quality comes from better road quality.

Growth benefits for North African countries fluctuate between 1.5 percent per year (Egypt and Tunisia) and 2.2 percent (Algeria) under this scenario—with most of the surge explained by higher infrastructure stocks and, specifically, the length of the road network, which contributes with more than 0.5 percent per year (figure 13, panel b). For West African countries, it is the increase of stocks in telecommunications and the electricity sectors that drive the contribution to growth of narrowing the infrastructure gap. Better road quality seems to contribute significantly in the quality dimension (figure 13, panel c). Growth is enhanced by more than 3 percent per year for East African countries under this scenario. Approximately 2.2–2.7 percent is attributed to infrastructure stocks, of which 1.6–2.1 is due to increasing telephone density and larger electricity-generating capacity. In addition, better road quality contributes with approximately 0.3 percent per year across East African nations (figure 13, panel d). Southern African countries (with the exception of Mauritius and South Africa) have a growth payoff that fluctuates between 2.2 percent per year (Botswana) and 3.6 percent (Democratic Republic of Congo), with most of the action coming from the telecommunications sector (figure 13, panel e). Finally, the potential growth contribution of infrastructure development to Central African countries ranges from 2.6 percent (Gabon) to 4.1 percent (Chad), with increasing infrastructure stocks explaining a larger share—from 1.7 to 3.4 percent per year.

4 Conclusions

The present report has provided an assessment of the effects of infrastructure development on economic growth in Africa and has helped identify some areas of opportunity across different types of infrastructure assets in terms of the potential growth benefits that they can achieve. Our report takes into account the development of different types of infrastructure (telecommunications, electricity, and roads) and not only measures improvements in terms of increasing accumulation of assets but also improvements in the quality of infrastructure services.

Our empirical evaluation estimates an infrastructure-augmented productivity growth-regression equation for a sample of 136 countries over the period 1960–2005, using nonoverlapping five-year period observations, and employing an instrumental variable (IV) technique that addresses potentially challenging issues such as unobserved country- and time-specific effects, as well as the potential reverse causality issues of the explanatory variables (including our infrastructure indicators).

Our main results can be summarized as follows.

(a) Growth is positively affected by the volume of infrastructure stocks and the quality of infrastructure services. Their impact is robust and statistically significant to changes in the aggregate index of infrastructure used. Our empirical estimates (see table 2) address the issue of reverse causality and survive a battery of statistical tests that fail to show any evidence of misspecification. From this we conclude that the above results reflect causal, and not merely coincidental, effects of infrastructure on productivity growth.

(b) Our simulations show that our empirical findings are significant not only statistically but also economically. For instance, if all African countries were to catch up with the region's leader, Mauritius, in terms of infrastructure stock and quality, their rate of economic growth would be enhanced—on average by 2.2 percent per year, and ranging from 0.6 to 3.5 percent (South Africa and Niger, respectively). Catching up with the EAP7 median would involve even larger gains (2.6 percent per year), though with a larger variation—that is, ranging from 0.4 to 3.9 percent per year (Mauritius and Niger, respectively). But we should point out that these catch-up scenarios implicitly assume potentially large investment efforts in the transition toward increased levels of infrastructure development.

Finally, when identifying areas of opportunity to trigger productivity growth we find that African countries have a higher probability of getting larger benefits from infrastructure development through larger stocks of infrastructure. The African infrastructure gap, especially with the representative countries in Western Europe and the EAP7, is still very large. But the payoffs are heterogeneous across subregions—with North Africa showing a narrower infrastructure gap and Central Africa showing the largest gap. In the case of North Africa, enlarging and improving the quality of the road network seems to show the largest payoffs in terms of infrastructure quantity and quality . On the other hand, although the gap is very large for all sectors, the growth payoff is larger in the sectors of telephone density, electricity-generating capacity, road-network length, and road quality.

References

Alesina, A., and R. Perotti. 1996. “Income Distribution, Political Instability, and Investment.” *European Economic Review* 40: 1202–1229.

Alonso-Borrego, C., Arellano, M. 1999. “Symmetrically Normalized Instrumental-Variable Estimation Using Panel Data.” *Journal of Business and Economics Statistics 17*, 36–49.

Arellano, M. and Bond, S., 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies 58 (2)*, 277–97.

Arellano, M. and Bover, O., 1995. "Another Look at the Instrumental Variable Estimation of Error-Component Models." *Journal of Econometrics 68 (1)*, 29–51.

Blanchard, O., and F. Giavazzi. 2004. “Improving the SGP Through Proper Accounting of Public Investment.” CEPR Discussion Paper 4220.

Blundell, R. and Bond, S., 1998. “Initial Conditions and Moment Restrictions in Dynamic Panel Data Models.” *Journal of Econometrics* 87 (1), 115–43.

Calderón, C., and A. Chong. 2004. “Volume and Quality of Infrastructure and the Distribution of Income: An Empirical Investigation.” *Review of Income and Wealth* 50: 87–105.

Calderón, C., and L. Servén. 2004a. “The Effects of Infrastructure Development on Growth and Income Distribution.” Policy Research Working Paper 3400, World Bank, Washington, DC.

———. 2004b. “Trends in Infrastructure in Latin America, 1980–2001.” Policy Research Working Paper 3401, World Bank, Washington, DC.

Canning, D. 1998. “A Database of World Stocks of Infrastructure, 1950–95.” *The World Bank Economic Review* 12: 529–547.

Easterly, W. 2001. “The Lost Decades: Explaining Developing Countries’ Stagnation in spite of Reform 1980–1998.” *Journal of Economic Growth* 6(2): 135–157.

Easterly, W., and R. Levine. 1997. “Africa’s Growth Tragedy: Policies and Ethnic Divisions.” *The Quarterly Journal of Economics* 112(4): 1203–1250.

Easterly, W., and L. Servén. 2003. *The Limits of Stabilization: Infrastructure, Public Deficits, and Growth in Latin America.* Washington, DC: World Bank; California: Stanford University Press.

Estache, A., V. Foster, and Q. Wodon. 2002. “Accounting for Poverty in Infrastructure Reform: Learning from Latin America’s Experience.” WBI Development Studies, World Bank, Washington, DC.

Galiani, S., P. Gertler, and E. Schargrodsky. 2005. “Water for Life: The Impact of the Privatization of Water Services on Child Mortality.” *Journal of Political Economy* 113(1): 83–120.

Hulten. 1996.

Hulten, C., 1996. "Infrastructure Capital and Economic Growth: How Well You Use It May Be More Important than How Much You Have." NBER Working Paper 5847, December.

Hussain, I., and R. Faruqee. 1994. *Adjustment in Africa: Lessons from Case Studies*. Washington, DC: World Bank.

Lederman, D., W. Maloney, and L. Servén. 2005. *Lessons from NAFTA for Latin America and the Caribbean*. Palo Alto and Washington, DC: Stanford University Press and World Bank.

Loayza, N., P. Fajnzylber, and C. Calderón. 2005. *Economic Growth in Latin America and the Caribbean: Stylized Facts, Explanations and Forecasts.* World Bank Latin American and Caribbean Studies. Washington, DC: World Bank.

Sánchez-Robles, B. 1998. "Infrastructure Investment and Growth: Some Empirical Evidence." *Contemporary Economic Policy* 16: 98–108.

Wheeler, D. 1984. "Sources of Stagnation in Sub-Saharan Africa." *World Development* 12: 1–23.

World Bank. 1994. World Development Report. Washington, DC: World Bank.

Appendix 1 Econometric methodology[15]

The evaluation of the effects of infrastructure development on productivity growth in our panel data set poses some econometric challenges that can be addressed in the context of a dynamic regression equation:

$$\begin{aligned} y_{it} - y_{it-1} &= \alpha y_{it-1} + \phi' K_{it} + \gamma' Z_{it} + \mu_t + \eta_i + \varepsilon_{it} \\ &= \alpha y_{it-1} + \beta' X_{it} + \mu_t + \eta_i + \varepsilon_{it} \end{aligned} \quad (1)$$

where y denotes the real GDP per worker (in logs), K is a set of standard growth or inequality determinants, and Z is a vector of infrastructure-related measures. The terms μ_t and η_i respectively denote an unobserved common factor affecting all countries, and a country effect capturing unobserved country characteristics. The second equality follows from defining $X_{it} = (K'_{it}, Z'_{it})'$ and $\beta = (\phi', \gamma')'$.

When estimating equation (1) we face the potential problem of endogenous regressors. This affects, in principle, both the standard determinants of productivity growth (variables in matrix K such as education, financial depth, inflation, and so on) and the infrastructure variables in matrix Z given that we can argue that these variables may be jointly determined. Indeed, this may be subject to reverse causality from labor productivity.[16] Furthermore, the lagged dependent variable y_{it} is also endogenous due to the presence of the country-specific effect.

We need suitable instruments to deal with endogeneity issues. Besides the terms-of-trade shocks—which we can assume are strictly exogenous—there are no obviously exogenous variables at hand to construct them, and we may rely primarily on *internal instruments* within the framework described by Arellano and Bond (1991). These instruments are provided by suitable lags of the variables. Note, however, that the presence of unobserved country characteristics likely means that $E[X_{is}\eta_i] \neq 0$, and hence lagged levels of the regressors are not valid instruments for (1). Therefore, we first eliminate the country-specific effect by taking first differences of equation (1):

$$y_{it} - y_{it-1} = (1+\alpha)\left(y_{it-1} - y_{it-2}\right) + \beta'\left(X_{it} - X_{it-1}\right) + \left(\varepsilon_{it} - \varepsilon_{it-1}\right) \quad (2)$$

Assuming that (a) the time-varying disturbance ε is not serially correlated, and (b) the explanatory variables X are weakly exogenous (that is, are uncorrelated with future realizations of the time-varying error term), lagged values of the endogenous and exogenous variables provide valid instruments.[17] In other terms, we assume that:

[15] The present appendix draws heavily from Calderón and Servén (2004a).

[16] For example, infrastructure accumulation could be driven by productivity growth.

[17] Note that this still allows current and future values of the explanatory variables to be affected by the error term.

$$E\left[y_{i,t-s}\cdot\left(\varepsilon_{i,t}-\varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s\geq 2; t=3,\dots,T \tag{3}$$

$$E\left[X_{i,t-s}\cdot\left(\varepsilon_{i,t}-\varepsilon_{i,t-1}\right)\right] = 0 \quad for\ s\geq 2; t=3,\dots,T \tag{4}$$

These conditions define the *GMM-difference* estimator. In spite of its simplicity, this has some potential shortcomings. When explanatory variables are persistent over time, their lagged levels are weak instruments for the regression equation in differences (Alonso-Borrego and Arellano 1999; Blundell and Bond 1998). This raises the asymptotic variance of the estimator and creates a small-sample bias.[18]

To avoid these problems, below we use a *system* estimator that combines the regression in differences and in levels (Arellano and Bover 1995; Blundell and Bond 1998). The instruments for the regression in differences are the same as above. The instruments for the regression in levels are the lagged *differences* of the corresponding variables. These are appropriate instruments under the additional assumption of no correlation between the *differences* of these variables and the country-specific effect. Formally, we assume

$$\begin{aligned} &E[y_{i,t+p}\cdot\eta_i]=E[y_{i,t+q}\cdot\eta_i] \quad and \\ &E[X_{i,t+p}\cdot\eta_i]=E[X_{i,t+q}\cdot\eta_i] \quad for\ all\ \ p\ and\ q \end{aligned} \tag{5}$$

This leads to additional moment conditions for the regression in levels:[19]

$$E[\left(y_{i,t-1}-y_{i,t-2}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)]=0 \tag{6}$$

$$E[\left(X_{i,t-1}-X_{i,t-2}\right)\cdot\left(\eta_i+\varepsilon_{i,t}\right)]=0 \tag{7}$$

Using the moment conditions in equations (3), (4), (6), and (7), we employ a GMM procedure to generate consistent estimates of the parameters of interest and their asymptotic variance–covariance (Arellano and Bond 1991; Arellano and Bover 1995). These are given by the following formulas:

$$\hat{\theta}=(\overline{X}'W\hat{\Omega}^{-1}W'\overline{X})^{-1}\overline{X}'W\hat{\Omega}^{-1}W'\overline{y} \tag{8}$$

$$AVAR(\hat{\theta})=(\overline{X}'W\hat{\Omega}^{-1}W'\overline{X})^{-1} \tag{9}$$

where θ is the vector of parameters of interest (α, β), $\overline{y}$ is the dependent variable stacked first in differences and then in levels, $\overline{X}$ is the explanatory-variable matrix including the lagged dependent variable (y_{t-1}, X) stacked first in differences and then in levels, W is the matrix of instruments derived from

[18] An additional problem with the simple *difference* estimator relates to measurement error: differencing may exacerbate the bias due to errors in variables by decreasing the signal-to-noise ratio (see Griliches and Hausman 1986).

[19] Given that lagged levels are used as instruments in the differences specification, only the most recent difference is used as an instrument in the levels specification. Using other lagged differences would result in redundant moment conditions (see Arellano and Bover 1995).

the moment conditions, and $\hat{\Omega}$ is a consistent estimate of the variance–covariance matrix of the moment conditions. [20]

Consistency of the GMM estimators depends on the validity of the above moment conditions. This can be checked through two specification tests suggested by Arellano and Bond (1991), and Arellano and Bover (1995). The first is a Sargan test of overidentifying restrictions, which tests the overall validity of the instruments by analyzing the sample analog of the moment conditions used in the estimation process. Failure to reject the null hypothesis that the conditions hold supports the model. Furthermore, validity of the *additional* moment conditions required by the system estimator relative to the difference estimator can likewise be verified through difference Sargan tests.

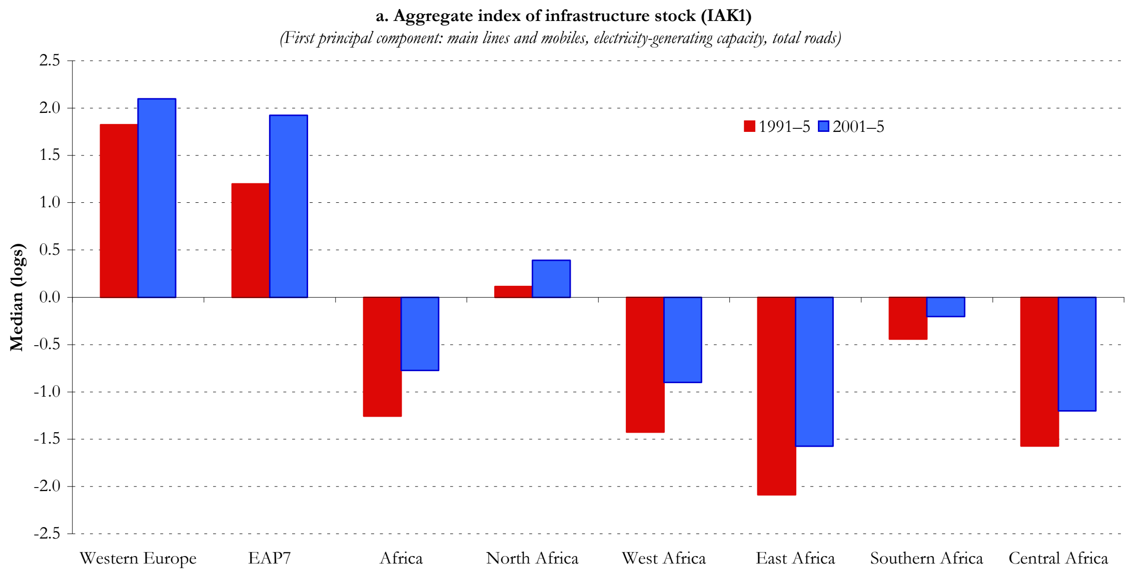
The second test examines the null hypothesis that the error term $\varepsilon_{i,t}$ is serially uncorrelated. As with the Sargan test, failure to reject the null lends support to the model. In the *system* specification, we test whether the differenced error term (that is, the residual of the regression in differences) shows second-order serial correlation. First-order serial correlation of the differenced error term is expected even if the original error term (in levels) is uncorrelated, unless the latter follows a random walk. Second-order serial correlation of the differenced residual indicates that the original error term is serially correlated and follows a moving average process at least of order one. This would render the proposed instruments invalid (and would call for higher-order lags to be used as instruments).

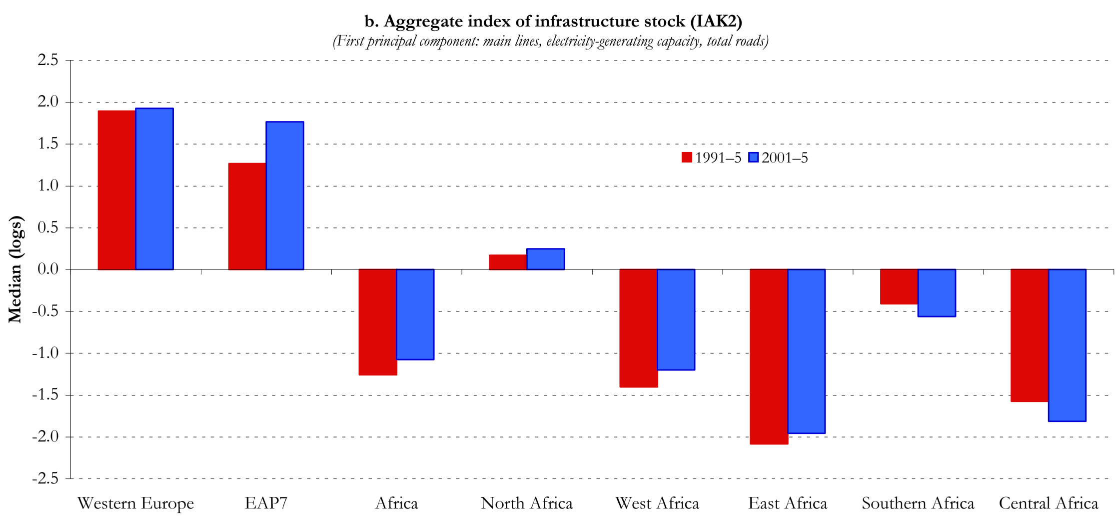
So far we have limited our discussion to internal instruments. But to double-check that our results concerning infrastructure are not driven by invalid instruments, we also experiment with a set of external instruments provided by demographic variables. This is motivated by the results of Canning (1998), and Roller and Waverman (2001), who show that much of the observed variation in infrastructure stocks is explained by demographic variables such as population density and urbanization. Thus, in some regressions, we drop all lags of the infrastructure indicators—both quality and quantity—from the set of instruments and replace them with current and lagged values of these demographic variables.

[20] In practice, Arellano and Bond (1991) suggest the following two-step procedure to obtain consistent and efficient GMM estimates. First, assume that the residuals, $\varepsilon_{i,t}$, are independent and homoskedastic both across countries and over time. This assumption corresponds to a specific weighting matrix that is used to produce first-step coefficient estimates. Then, construct a consistent estimate of the variance-covariance matrix of the moment conditions with the residuals obtained in the first step, and use this matrix to reestimate the parameters of interest (that is, second-step estimates). Asymptotically, the second-step estimates are superior to the first-step ones in so far as efficiency is concerned.

Figures and tables

Figure 1. Aggregate infrastructure stock and quality, 1991–2005





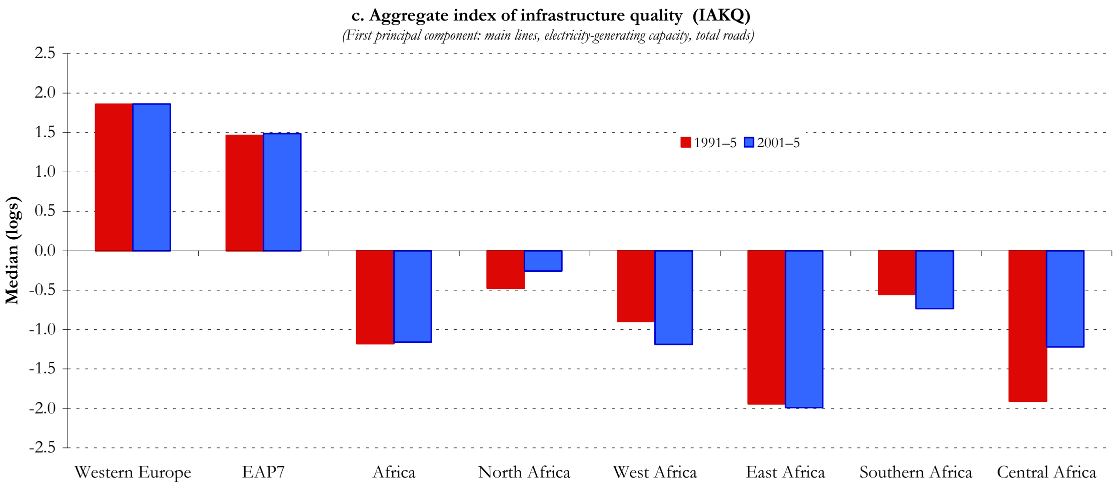
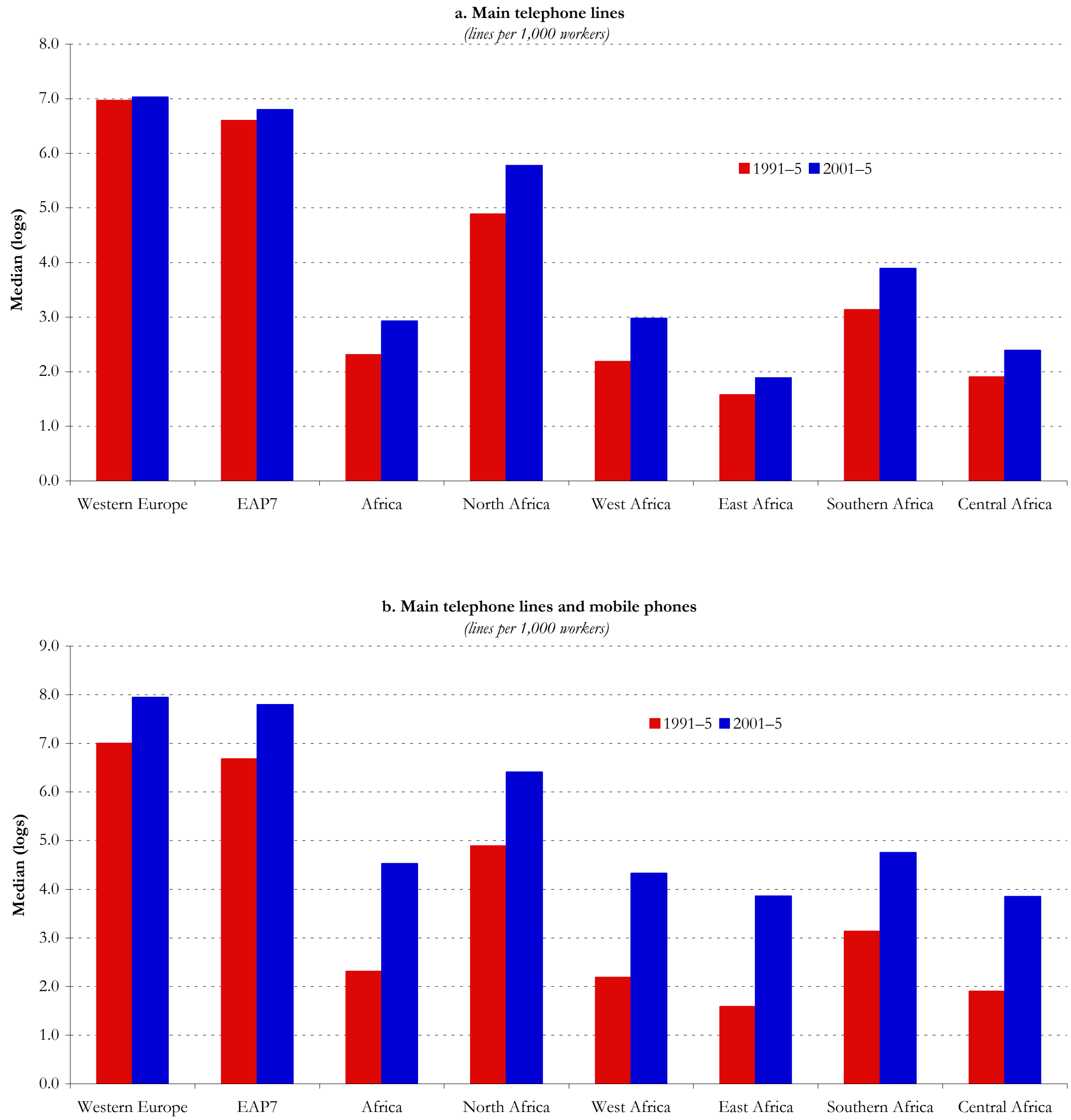

c. Aggregate index of infrastructure quality (IAKQ)
(First principal component: main lines, electricity-generating capacity, total roads)
Median (logs)
2.5
2.0
1.5
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
-2.5
1991–5
2001–5
Western Europe
EAP7
Africa
North Africa
West Africa
East Africa
Southern Africa
Central Africa

Figure 2. Telecommunications infrastructure, 1991–2005



c. Quality of telecommunications services
(based on waiting time for main-line installation)

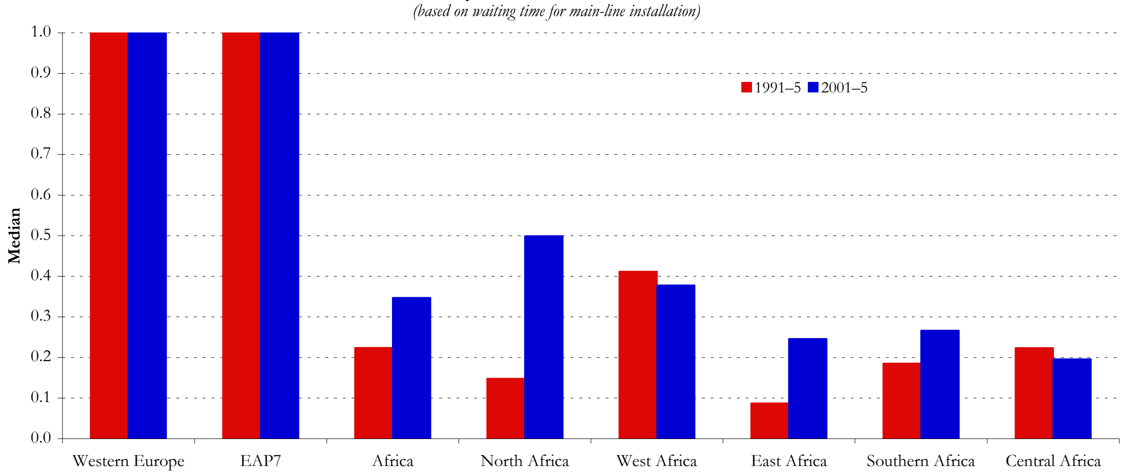
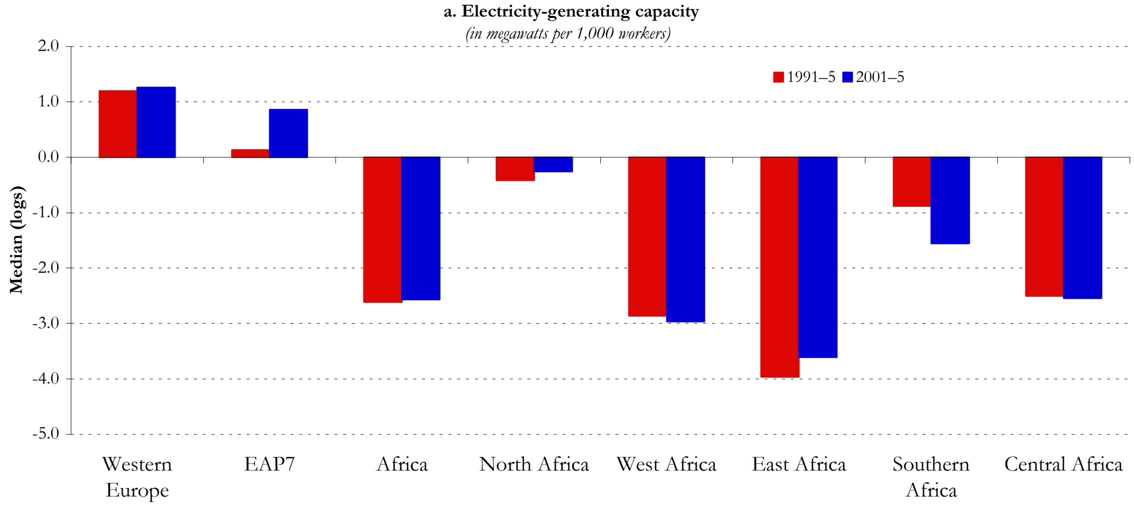


Figure 3. Electric power infrastructure, 1991–2005



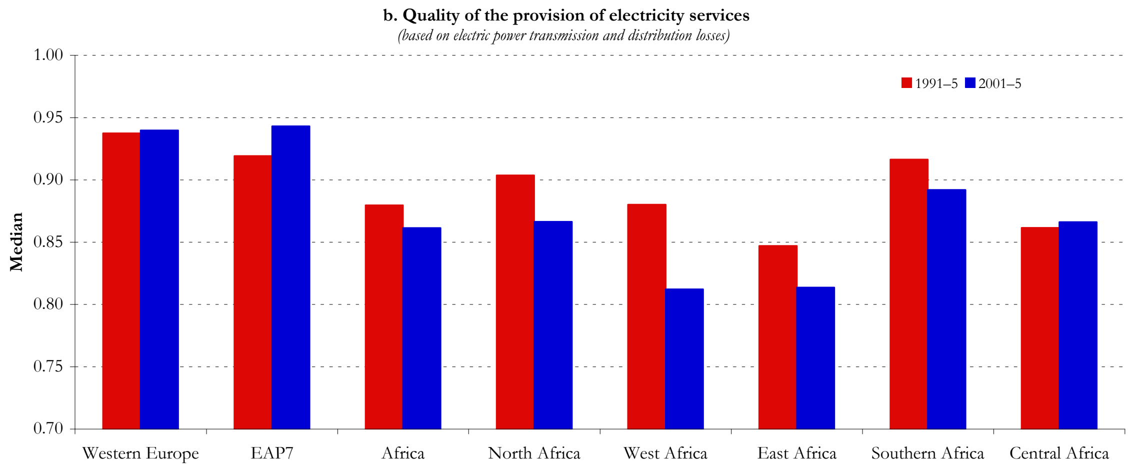
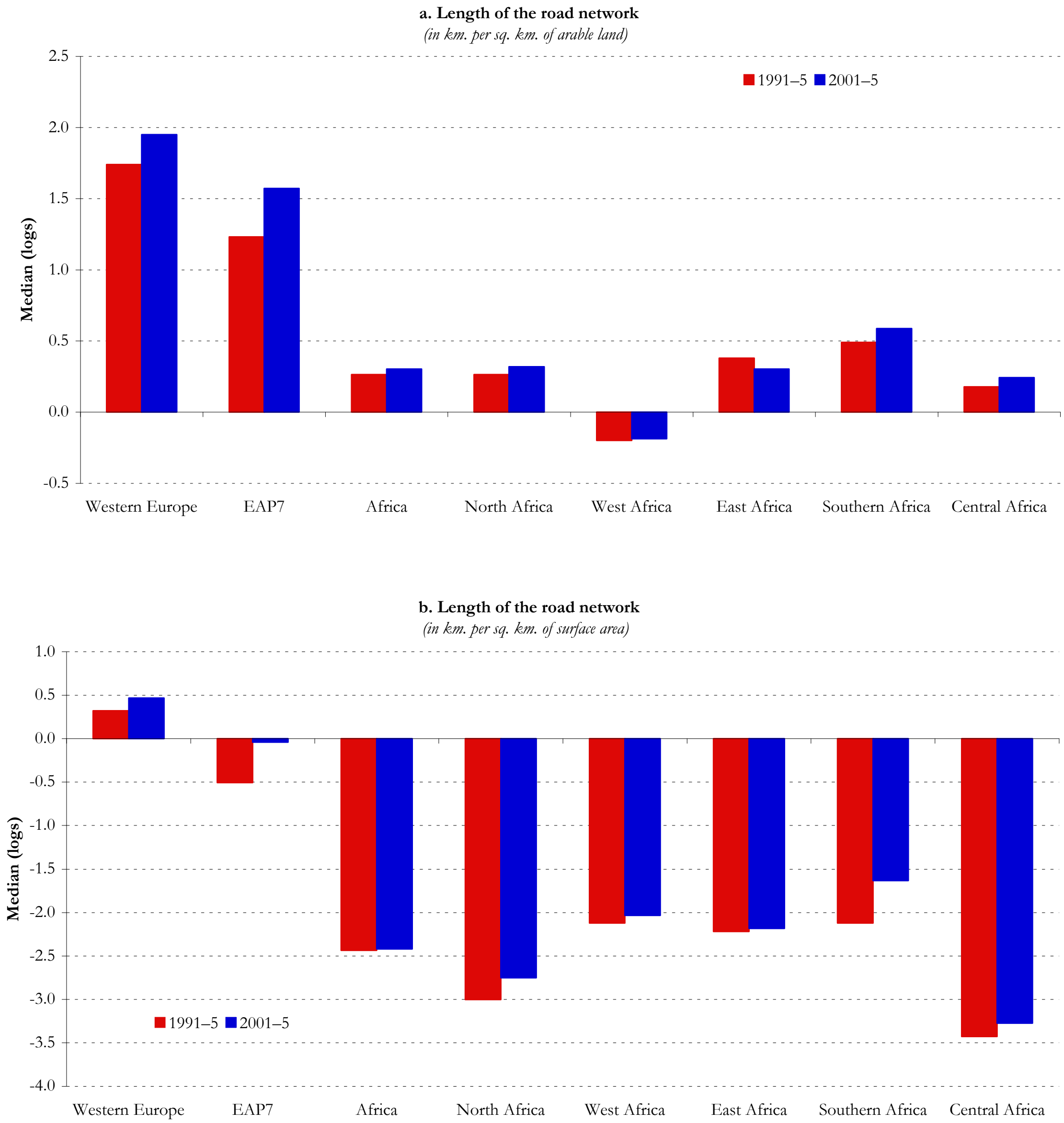


Figure 4. Road infrastructure, 1991–2005



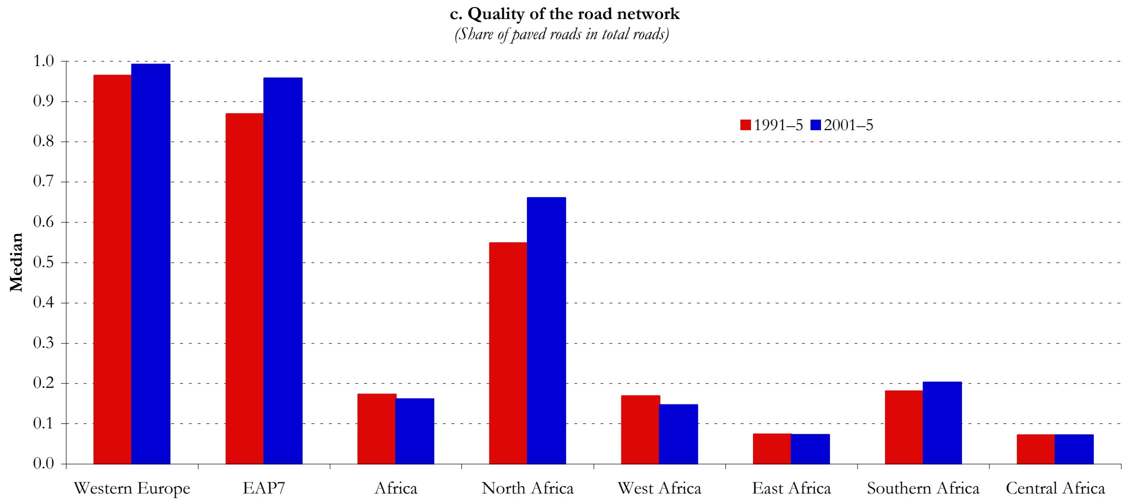
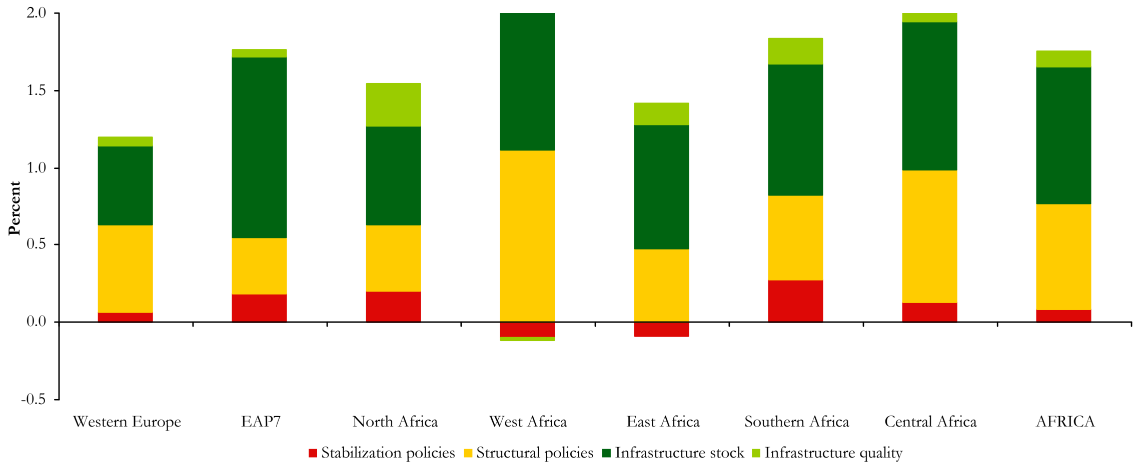

c. Quality of the road network
(Share of paved roads in total roads)
1991–5
2001–5
Median
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
Western Europe
EAP7
Africa
North Africa
West Africa
East Africa
Southern Africa
Central Africa

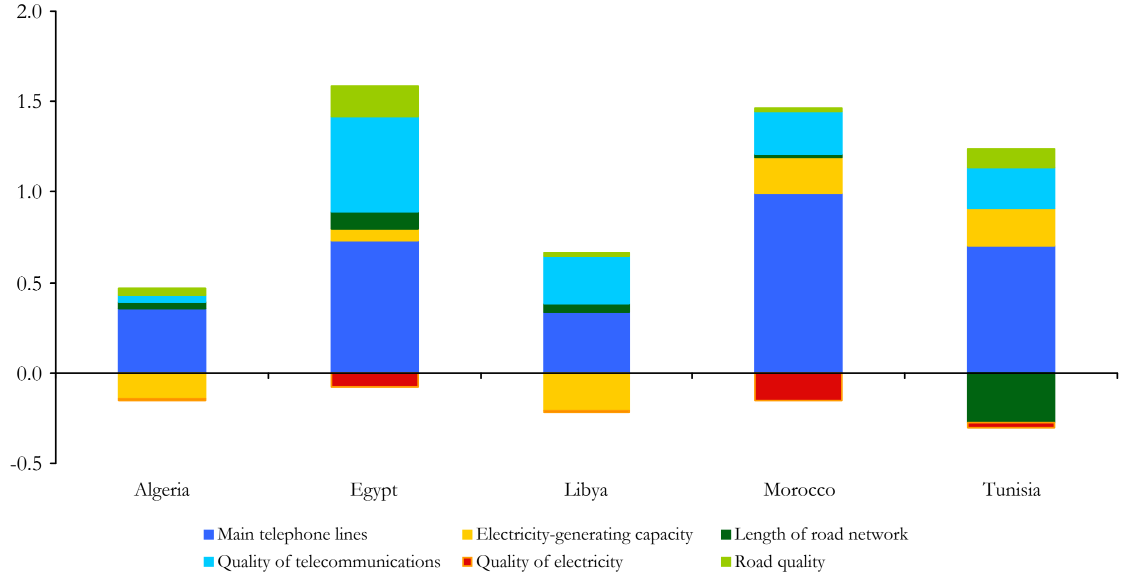
Figure 5. Changes in growth per capita due to changes in growth fundamentals across regions, 2001–5 versus 1991–5, Using [IK1] index of aggregate infrastructure services



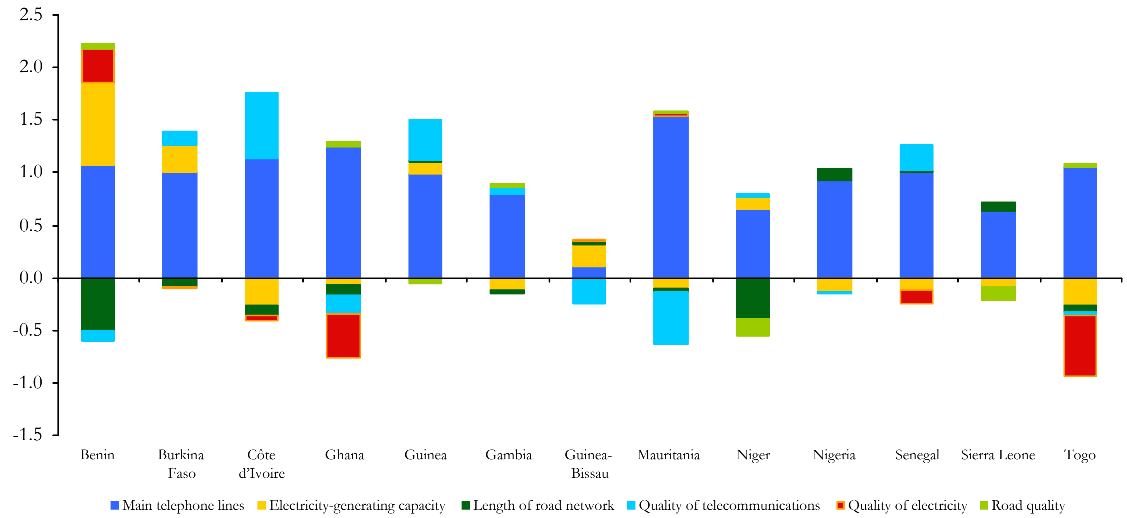
Note: The aggregate index of infrastructure stocks [IK1] summarizes information on telephone main lines and mobile phones (per 1000 workers), electricity generating capacity (in MW per 1000 workers, and the length of the total road network (in km. per sq. km. of arable land).

Figure 6. Changes in growth per capita in Africa due to changes in infrastructure development, 2001–5 versus 1991–5, using [IK1] index of aggregate infrastructure services

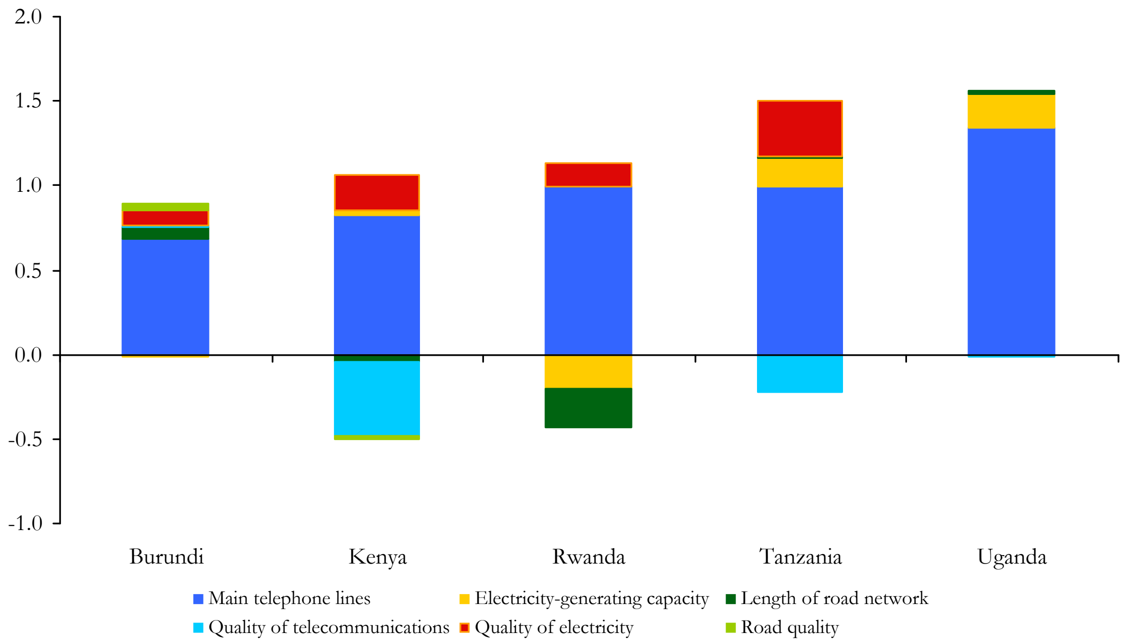
a. North Africa



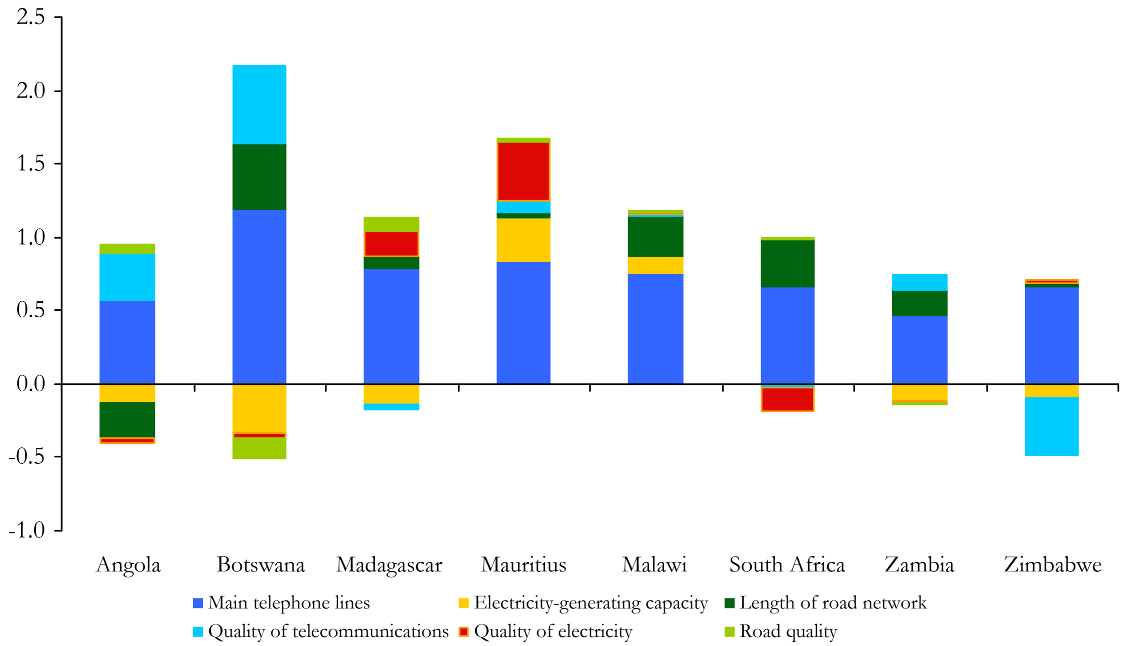
b. West Africa (ECOWAS)



c. East Africa (EAC)



d. Southern Africa (SADC)



e. Central Africa

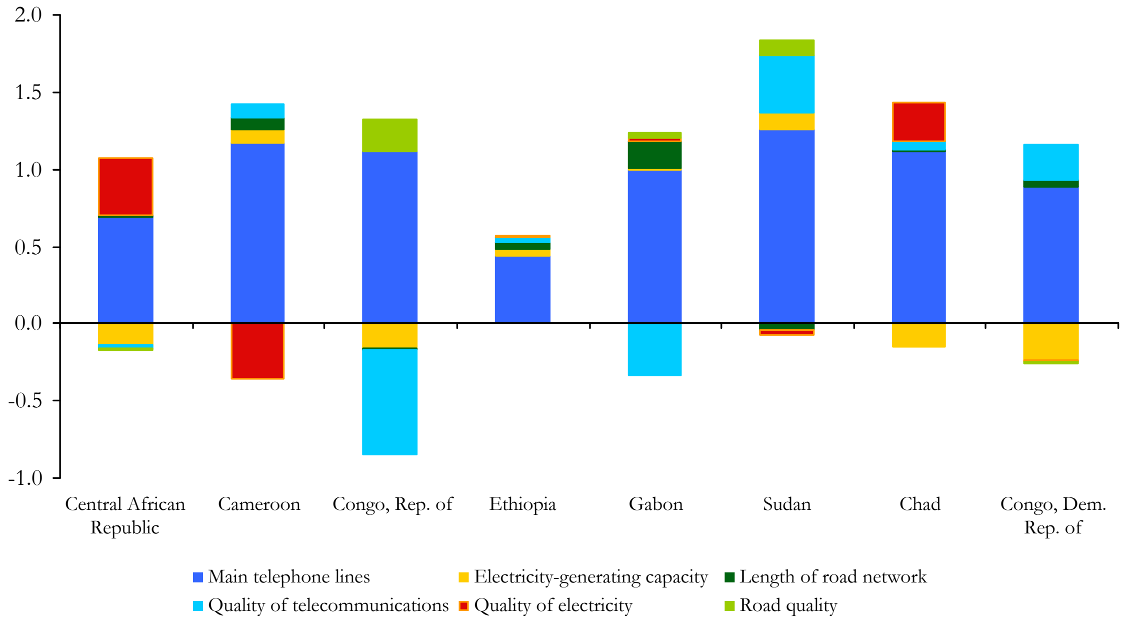
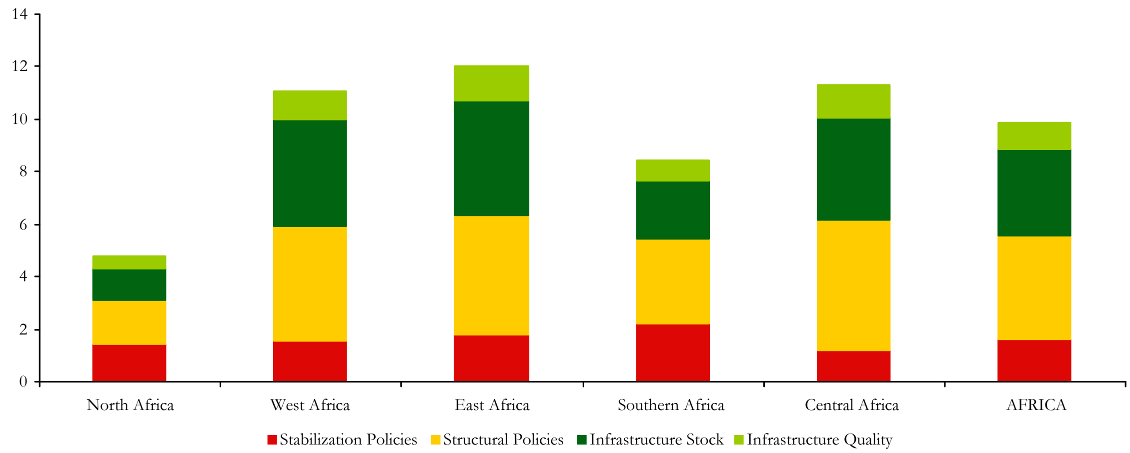
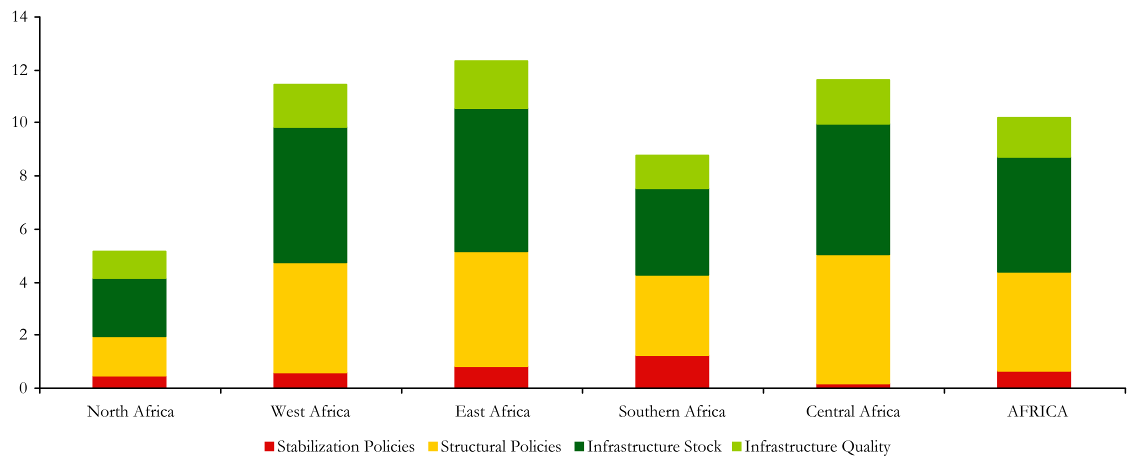


Figure 7. Potential growth per capita benefits in Africa due to better growth fundamentals, using the [IK1] index of aggregate infrastructure and 2001–5 averages

Scenario 1: Reaching the leader in Africa



Scenario 2: Reaching the representative country among the EAP7



Scenario 4: Reaching the representative country in Western Europe

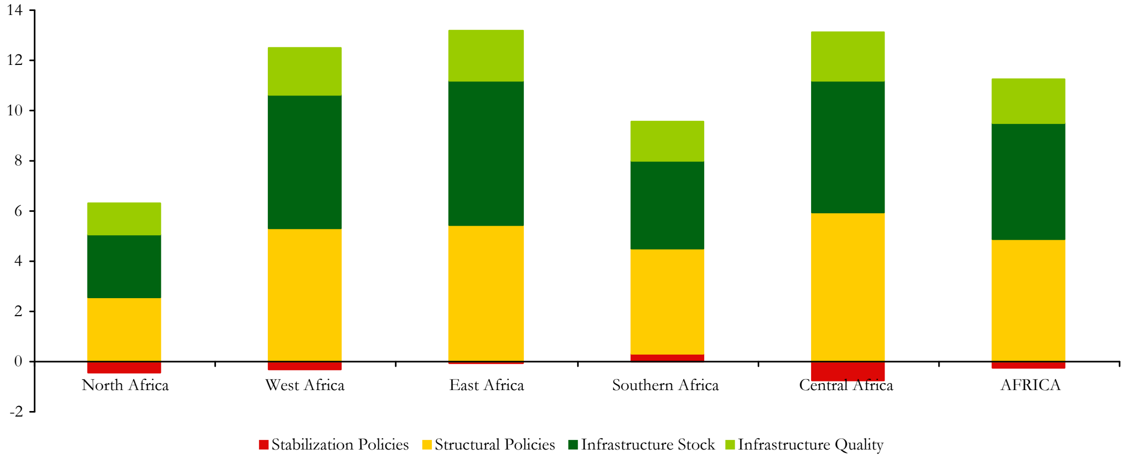
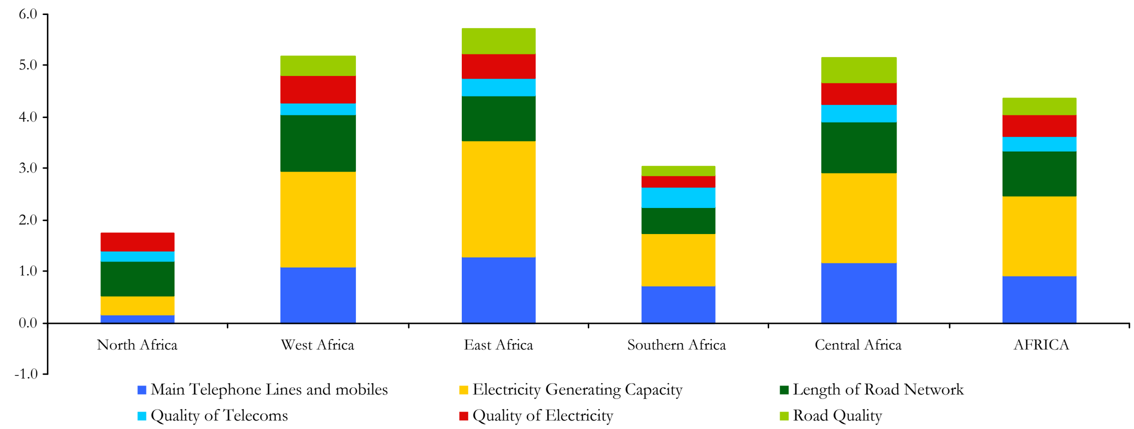


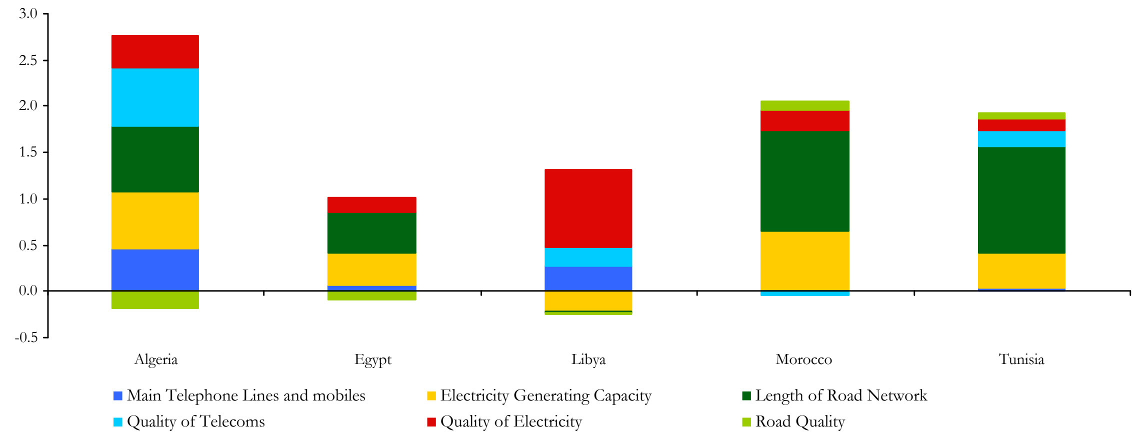
Figure 8. Potential growth per capita benefits in Africa due to higher infrastructure development

Scenario 1: Reaching the infrastructure level of the leader in Africa, using the [IK1] index of aggregate infrastructure and 2001–5 averages

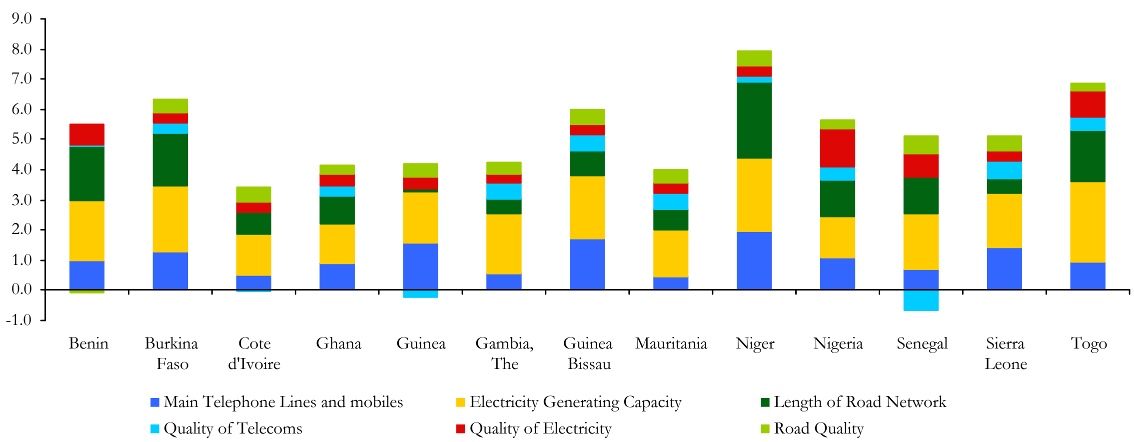
a. Africa



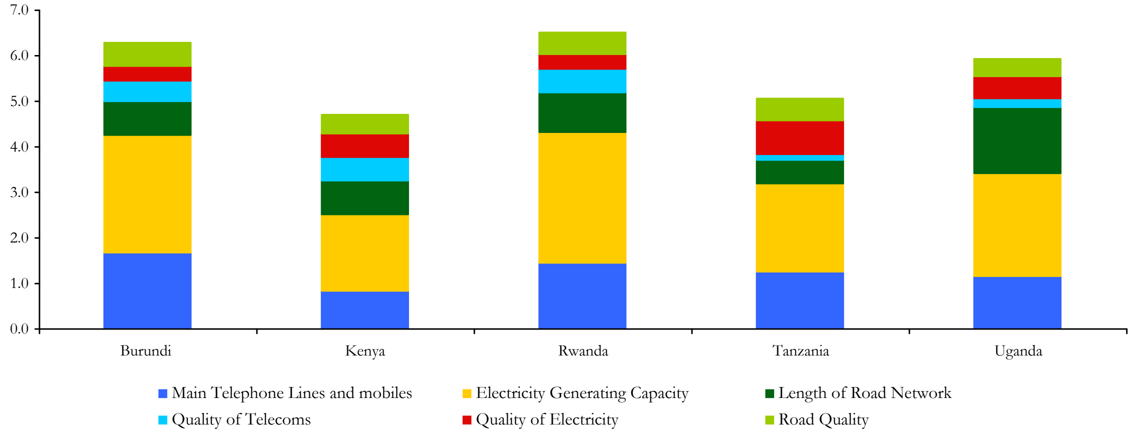
b. North Africa



c. West Africa (ECOWAS)



d. East Africa (EAC)



e. Southern Africa (SADC)

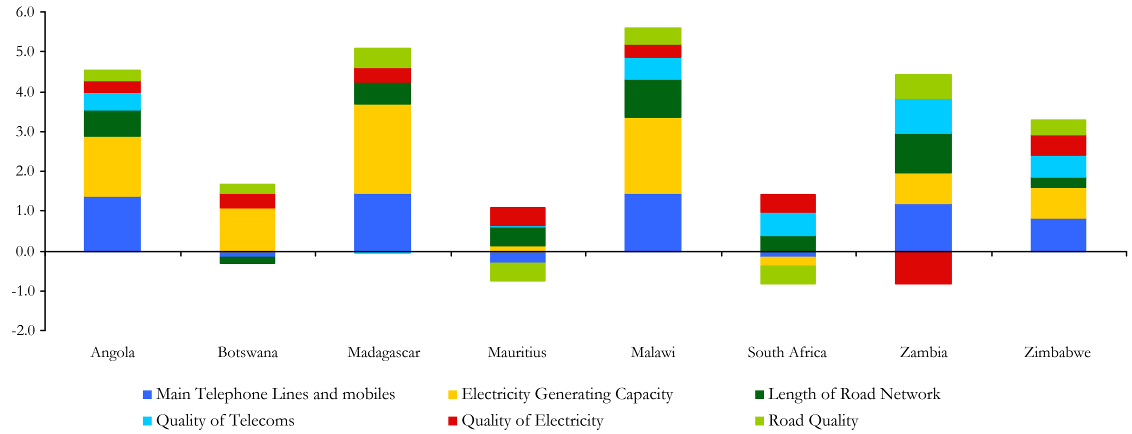
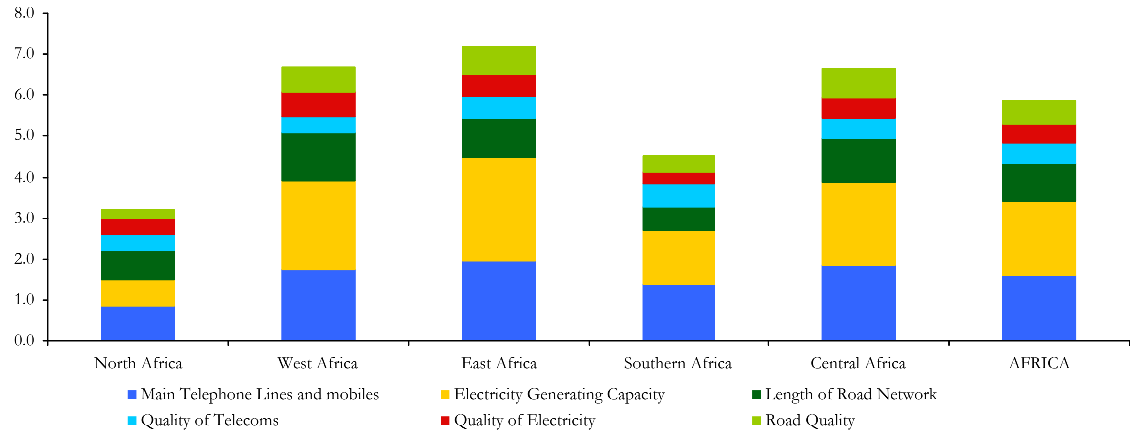


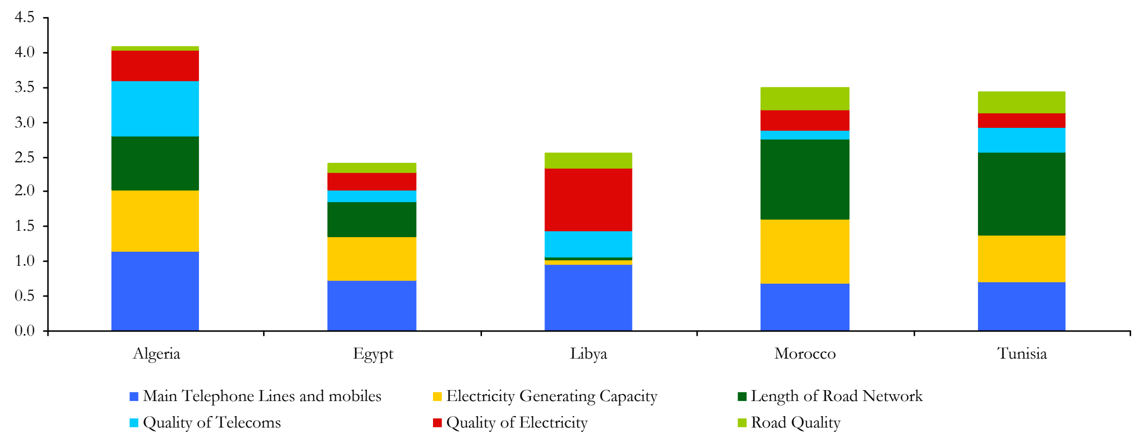
Figure 9. Potential growth per capita benefits in Africa due to higher infrastructure development

Scenario 2: Reaching the infrastructure level of the median in the EAP7, using the [IK1] index of aggregate infrastructure and 2001–5 averages

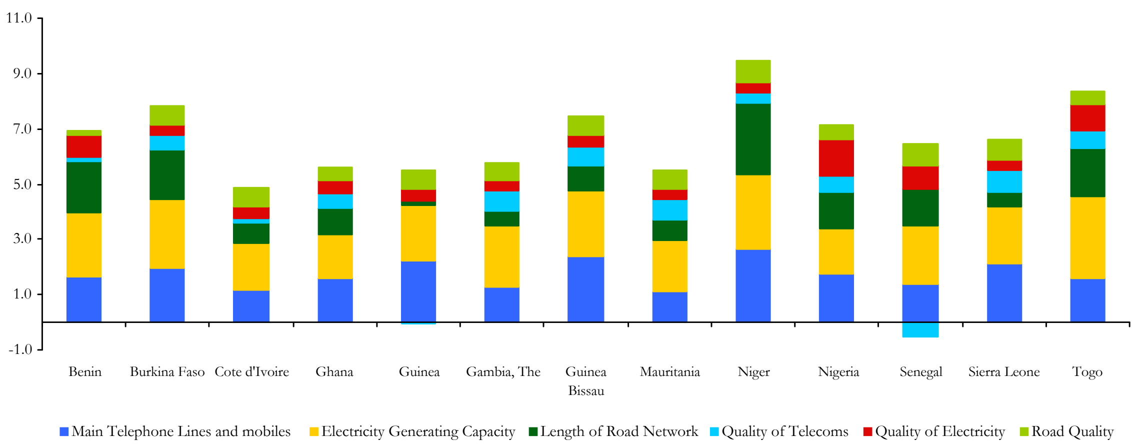
a. Africa



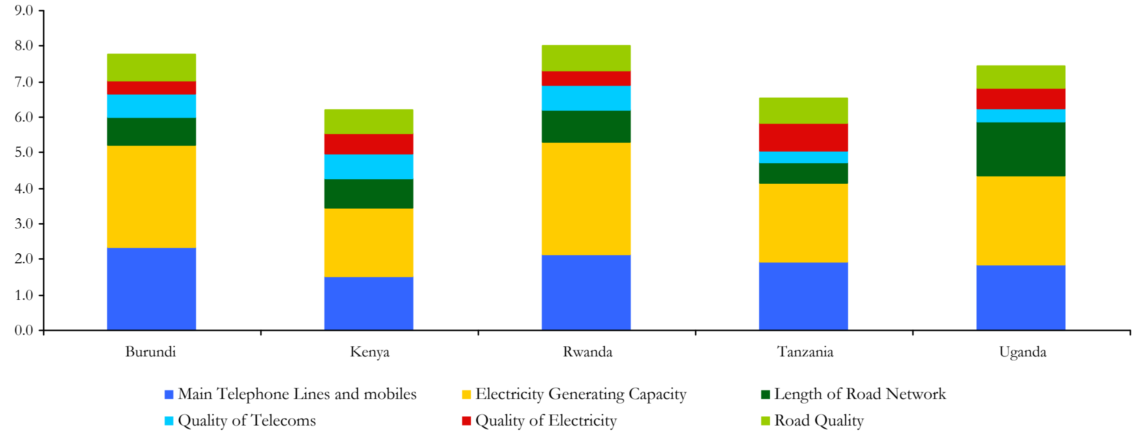
b. North Africa



c. West Africa (ECOWAS)



d. East Africa (EAC)



e. Southern Africa (SADC)

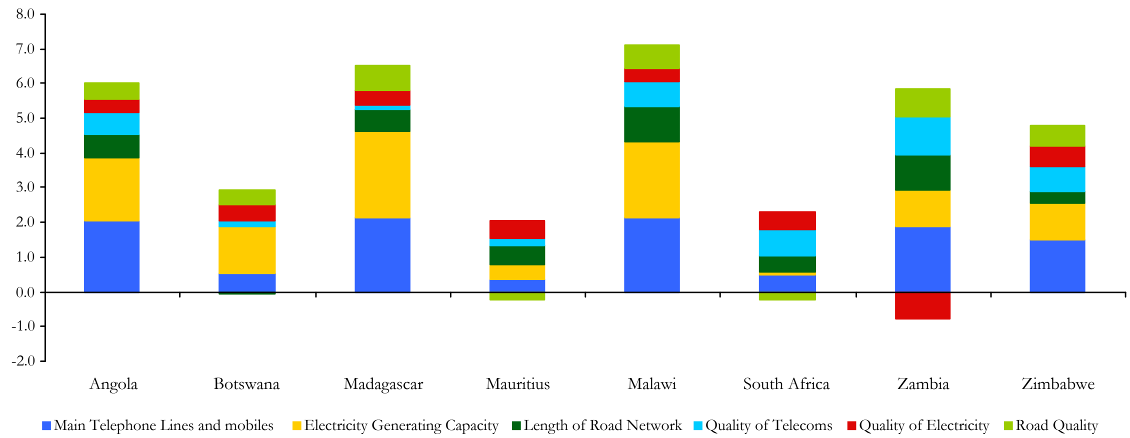
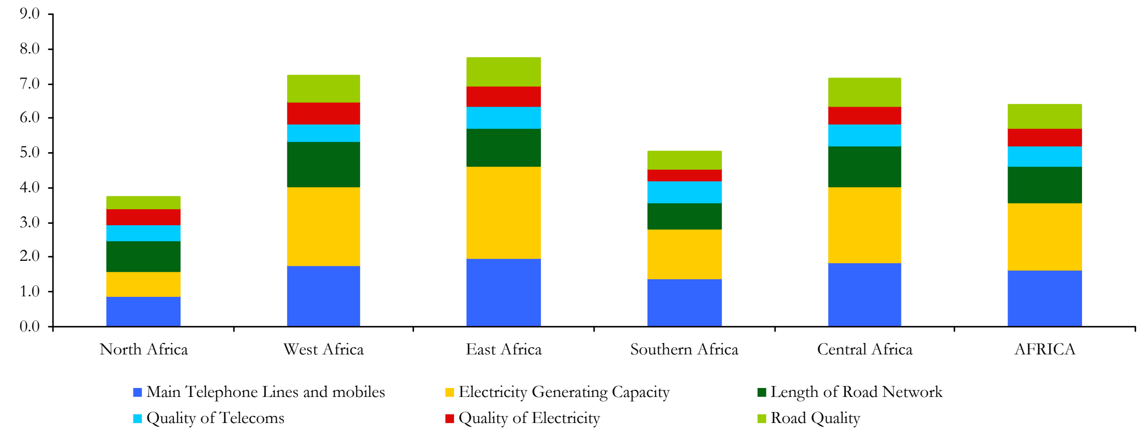


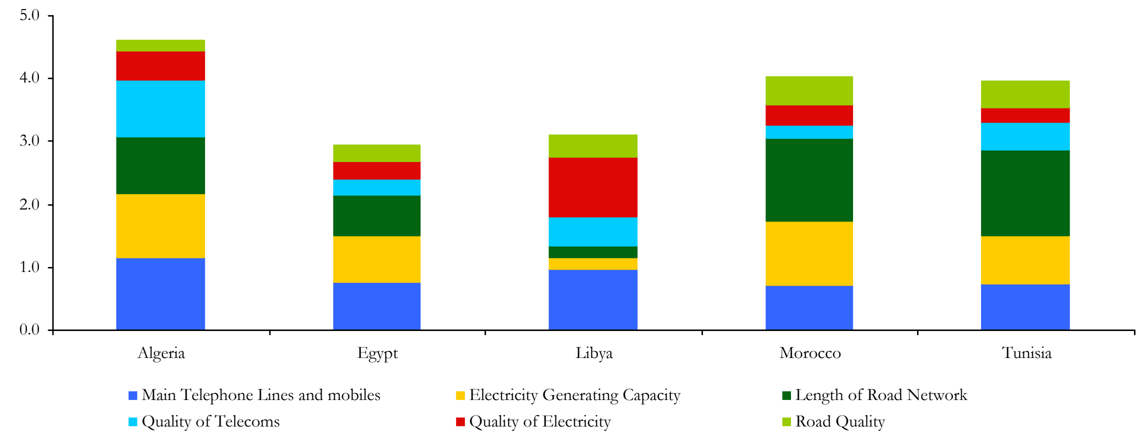
Figure 10. Potential growth per capita benefits in Africa due to higher infrastructure development

Scenario 4: Reaching the infrastructure level of the median in Western Europe, using the [IK1] index of aggregate infrastructure and 2001–5 averages

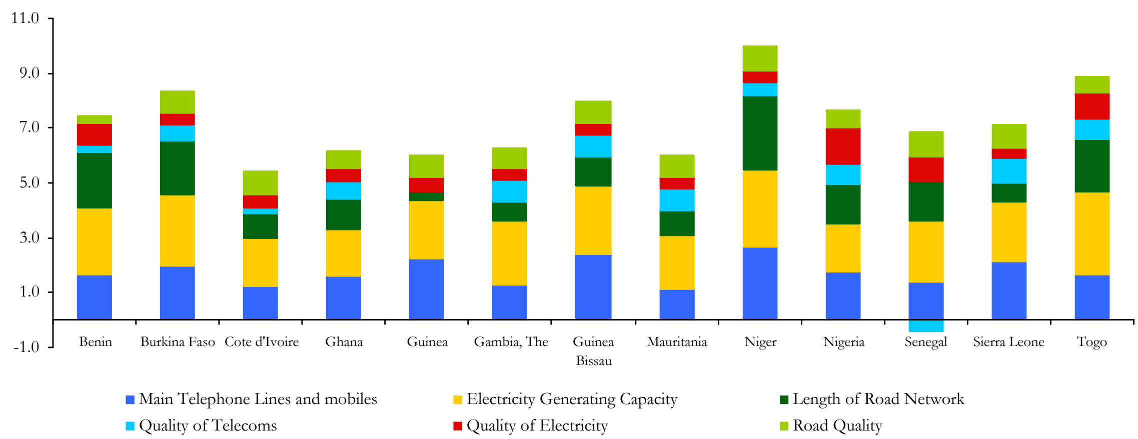
a. Africa



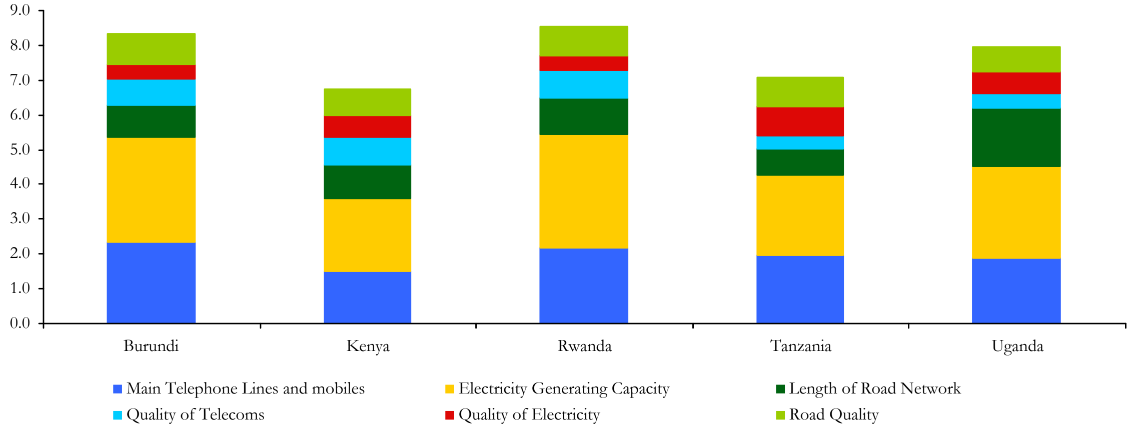
b. North Africa



c. West Africa (ECOWAS)



d. East Africa (EAC)



e. Southern Africa (SADC)

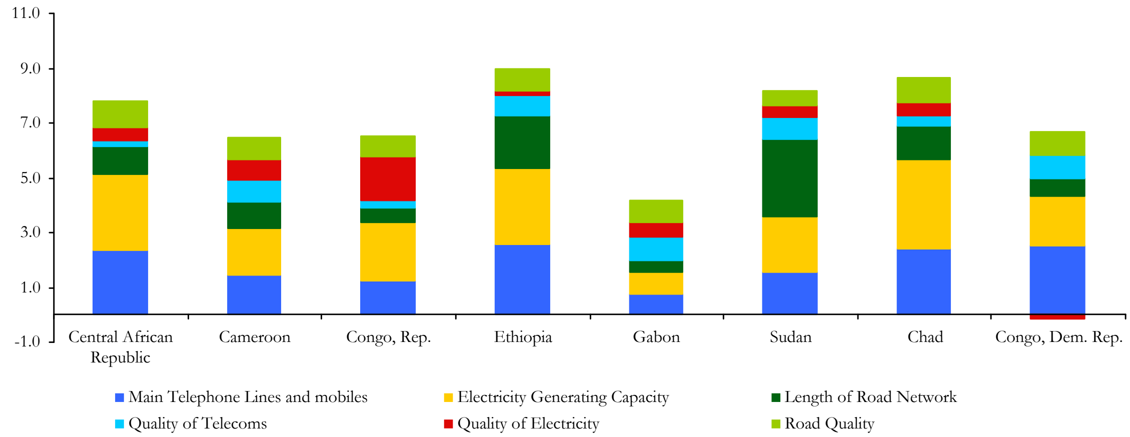


Table 1. Aggregating infrastructure variables: principal components analysis

(first eigenvector, correlation)

Variable	Aggregate infrastructure indices Stock [IK1]	Stock [IK2]	Stock [IK1a]	Stock [IK2a]	Quality of services
I. Stocks					
Telephone main lines and mobile phones	0.603	..	0.614	..	..
(per 100 workers)	(0.943)		(0.949)		
Telephone main lines	..	0.606	..	0.616	..
(per 100 workers)		(0.935)		(0.957)	
Electricity-generating capacity	0.613	0.614	0.606	0.606	..
(in megawatts per 1,000 workers)	(0.956)	(0.950)	(0.936)	(0.941)	
Total roads - arable land	0.510	0.506	..	..	..
(in km. per sq. km. of arable land)	(0.788)	(0.791)			
Total roads	..	..	0.506	0.503	..
(in km. per sq. km. of surface area)			(0.783)	(0.781)	
II. Quality of infrastructure services					
Telecommunications	..	..	..	..	0.608
(based on waiting time for installation)					(0.813)
Electricity	..	..	..	..	0.559
(based on energy losses)					(0.746)
Roads	..	..	..	..	0.564
(based on paved roads)					(0.754)
Eigenvalue	2.39	2.41	2.40	2.42	1.79
Variance Proportion	79.6%	80.4%	80.1%	80.8%	59.5%

*Note: We report the first eigenvector resulting from the principal component analysis of infrastructure proxies in telecommunications, electricity, and roads. For instance, the first aggregate index [IK1] is obtained using the following formula: IK1 = 0.603*K1 + 0.613*K2 + 0.510*K3, where K1, K2 and K3 represent (standardized) physical measures of infrastructure stocks in telecommunications, electricity, and roads. In addition, the numbers in parentheses (below the different eigenvectors) represent the correlation of the first principal component with the corresponding infrastructure variable.*

Table 2. Infrastructure and growth: panel regression analysis

Dependent variable: Growth in real GDP per capita (annual average)
Sample: 93 countries, 1960–2005 (non-overlapping 5-year period observations)
Estimation: GMM-IV system estimation

Variable	**[IK1]**	**[IK2]**	**[IK1a]**	**[IK2a]**
Infrastructure development:				
Infrastructure stock 1/	1.685 **	0.809 **	1.144 **	1.059 **
(first principal component of stocks)	(0.22)	(0.18)	(0.12)	(0.19)
Quality of infrastructure services 2/	0.630 **	0.590 **	0.173 **	0.304 **
(first principal component of quality measures)	(0.07)	(0.06)	(0.06)	(0.06)
Control variables				
Initial GDP per capita	-2.796 **	-1.735 **	-2.072 **	-2.313 **
(in logs)	(0.17)	(0.18)	(0.14)	(0.18)
Education	1.305 **	0.852 **	0.982 **	1.650 **
(secondary enrollment, in logs)	(0.14)	(0.20)	(0.17)	(0.19)
Financial development	0.707 **	0.807 **	0.973 **	0.835 **
(private domestic credit as % of GDP, logs)	(0.08)	(0.09)	(0.12)	(0.12)
Trade openness	-0.461 **	-0.141 **	-0.109 **	-0.152 **
(trade volume as % of GDP, logs)	(0.06)	(0.07)	(0.05)	(0.07)
Institutional quality	3.217 **	2.923 **	3.063 **	2.610 **
(ICRG political risk index, logs)	(0.22)	(0.19)	(0.19)	(0.23)
Lack of price stability	-1.843 **	-1.343 **	-1.934 **	-1.883 **
(inflation rate)	(0.12)	(0.19)	(0.20)	(0.20)
Government burden	-1.661 **	-2.003 **	-0.886 **	-0.537 **
(Government consumption as % GDP, logs)	(0.19)	(0.22)	(0.24)	(0.22)
Terms of trade shocks	0.056 **	0.056 **	0.063 **	0.055 **
(first differences of log terms of trade)	(0.01)	(0.01)	(0.01)	(0.01)
No. countries	93	93	93	93
No. observations	580	580	580	580
Specification tests (p-values)				
(a) Sargan test:	(0.264)	(0.517)	(0.417)	(0.517)
(b) Serial correlation				
Second-order	(0.224)	(0.272)	(0.244)	(0.235)

*Our regression analysis includes an intercept and period-specific dummy variables (not reported here but available from the author). Robust standard errors are reported in parenthesis below the coefficient estimates. ** (*) implies significance at the 5% (10%) level. 1/ Each column of table 2 uses the different aggregate indices of infrastructure stocks reported in table 1. 2/ Our aggregate measure of infrastructure quality uses transformations of the following variables: waiting for main line installation (in years), electric power transmission and distribution losses (as a share of electric output), and the share of paved roads in total roads.*

Table 3. Changes in the growth rate due to growth determinants across regions, 2001–5 versus 1991–5

Using IK1 index of aggregate infrastructure stocks
Explaining change in the growth rate of real GDP per capita across regions

Variable	Growth change: Actual	Growth change: Predicted	Transitional convergence	Structural policies	Stabilization policies	External factors	Infrastructure development: Total	Infrastructure development: Stock	Infrastructure development: Quality
3.1 Using [IK1] index of infrastructure stocks:			*Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (in megawatts per 1,000 workers), length of total road network (in km. per sq. km. of arable land)*						
Western Europe	-0.28	**-0.19**	-0.53	0.56	0.07	-0.86	**0.57**	0.51	0.06
EAP7	-2.96	**-0.36**	-1.21	0.37	0.18	-0.91	**1.21**	1.17	0.05
North Africa	3.13	**0.59**	-0.19	0.42	0.21	-0.76	**0.92**	0.64	0.28
West Africa	3.61	**1.19**	0.00	1.12	-0.10	-0.71	**0.88**	0.90	-0.02
East Africa	2.28	**0.47**	0.24	0.47	-0.09	-1.10	**0.94**	0.80	0.14
Southern Africa	2.21	**1.23**	0.17	0.55	0.27	-0.77	**1.01**	0.85	0.16
Central Africa	3.68	**2.07**	0.20	0.86	0.13	-0.20	**1.08**	0.96	0.13
AFRICA	3.88	**1.10**	0.12	0.68	0.08	-0.77	**0.99**	0.89	0.10
3.2 Using [IK2] index of infrastructure stocks:			*Main telephone lines (per 1,000 workers), electricity-generating capacity (in megawatts per 1,000 workers), length of total road network (in km. per sq. km. of arable land)*						
Western Europe	-0.28	**0.33**	-0.33	0.58	0.07	-0.12	**0.12**	0.07	0.05
EAP7	-2.96	**-0.03**	-0.75	0.33	0.20	-0.17	**0.37**	0.33	0.04
North Africa	3.13	**0.81**	-0.12	0.37	0.18	-0.02	**0.40**	0.14	0.26
West Africa	3.61	**0.86**	0.00	0.85	-0.16	0.03	**0.14**	0.16	-0.02
East Africa	2.28	**0.18**	0.15	0.39	-0.23	-0.36	**0.23**	0.10	0.13
Southern Africa	2.21	**1.07**	0.11	0.45	0.26	-0.03	**0.29**	0.14	0.15
Central Africa	3.68	**1.81**	0.12	0.84	0.10	0.54	**0.21**	0.09	0.12
AFRICA	3.88	**0.87**	0.07	0.57	0.04	-0.03	**0.22**	0.13	0.09

The figures presented in table 3 represent the predicted increase in the growth rate of output per capita in 2001–5 relative to 1991–5 attributed to changes in the growth fundamentals.
In calculating the contribution of infrastructure to predicted growth, we use the [IK1] index of aggregate infrastructure stocks and the regression [IK1] in table 2.
Source: Author's calculations.

Table 4. Growth changes due to infrastructure development in Africa, 2001–5 versus 1991–5, Using [IK1] index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
Explaining change in the growth rate of real GDP per capita across African countries

Country	Infrastructure fevelopment	Infrastructure dtock				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	0.92	0.64	0.56	0.05	0.03	0.28	0.26	-0.03	0.05
Algeria	0.31	0.24	0.36	-0.15	0.03	0.07	0.04	-0.01	0.04
Egypt	1.51	0.89	0.73	0.07	0.09	0.62	0.53	-0.07	0.17
Libya	0.45	0.17	0.33	-0.20	0.04	0.28	0.27	-0.01	0.02
Morocco	1.31	1.21	1.00	0.19	0.02	0.10	0.23	-0.16	0.02
Tunisia	0.93	0.64	0.70	0.21	-0.27	0.29	0.22	-0.03	0.10
West Africa (ECOWAS)	0.88	0.90	1.03	-0.09	-0.04	-0.02	-0.03	0.01	0.00
Benin	1.63	1.36	1.07	0.79	-0.50	0.27	-0.10	0.33	0.04
Burkina Faso	1.29	1.18	1.00	0.26	-0.09	0.11	0.14	-0.01	-0.01
Côte d'Ivoire	1.35	0.76	1.13	-0.27	-0.10	0.58	0.63	-0.05	0.00
Ghana	0.53	1.08	1.24	-0.07	-0.09	-0.55	-0.19	-0.41	0.05
Guinea	1.45	1.12	0.99	0.11	0.02	0.34	0.39	-0.03	-0.03
Gambia	0.74	0.65	0.79	-0.12	-0.03	0.09	0.06	-0.01	0.04
Guinea-Bissau	0.13	0.34	0.11	0.21	0.03	-0.21	-0.24	0.02	0.01
Mauritania	0.95	1.40	1.53	-0.10	-0.04	-0.45	-0.50	0.04	0.00
Niger	0.25	0.37	0.66	0.10	-0.40	-0.12	0.03	0.01	-0.16
Nigeria	0.88	0.90	0.92	-0.13	0.11	-0.02	-0.02	0.00	-0.01
Senegal	1.02	0.90	1.01	-0.11	0.01	0.12	0.25	-0.12	-0.01
Sierra Leone	0.51	0.62	0.64	-0.09	0.07	-0.11	0.00	0.01	-0.12
Togo	0.15	0.72	1.05	-0.27	-0.06	-0.58	-0.03	-0.58	0.03
East Africa (EAC)	0.94	0.80	0.78	0.02	0.01	0.14	0.01	0.15	-0.02
Burundi	0.89	0.75	0.69	-0.01	0.07	0.14	0.01	0.09	0.05
Kenya	0.57	0.80	0.83	0.02	-0.05	-0.23	-0.43	0.22	-0.02
Rwanda	0.70	0.56	0.99	-0.21	-0.22	0.14	0.00	0.14	0.00
Tanzania	1.36	1.17	0.99	0.17	0.01	0.19	-0.22	0.33	0.08
Uganda	1.54	1.56	1.34	0.19	0.02	-0.01	-0.01	0.00	0.00
Southern Africa (SADC)	1.01	0.85	0.83	-0.13	0.15	0.16	0.21	-0.08	0.02
Angola	0.55	0.20	0.57	-0.12	-0.25	0.35	0.33	-0.03	0.05
Botswana	1.66	1.30	1.19	-0.33	0.44	0.35	0.53	-0.03	-0.15
Madagascar	0.97	0.73	0.79	-0.14	0.08	0.24	-0.03	0.17	0.09
Mauritius	1.67	1.17	0.83	0.31	0.03	0.50	0.07	0.41	0.01
Malawi	1.18	1.14	0.76	0.11	0.27	0.04	0.02	0.01	0.01
South Africa	0.80	0.98	0.66	-0.01	0.32	-0.17	-0.01	-0.17	0.01
Zambia	0.60	0.52	0.47	-0.12	0.18	0.08	0.10	-0.01	-0.01
Zimbabwe	0.23	0.59	0.67	-0.10	0.02	-0.36	-0.38	0.03	-0.01
Central Africa	1.08	0.96	1.00	-0.06	0.02	0.13	0.16	-0.03	0.00
Central African Republic	0.89	0.55	0.69	-0.14	0.00	0.34	-0.02	0.37	-0.01
Cameroon	1.07	1.33	1.17	0.08	0.08	-0.27	0.09	-0.36	0.00
Congo, Rep. of	0.48	0.94	1.12	-0.16	-0.02	-0.46	-0.67	0.00	0.20
Ethiopia	0.58	0.53	0.44	0.04	0.05	0.05	0.03	0.01	0.00
Gabon	0.90	1.18	1.00	0.01	0.18	-0.28	-0.33	0.02	0.03
Sudan	1.76	1.33	1.26	0.12	-0.04	0.43	0.37	-0.04	0.10
Chad	1.29	0.97	1.12	-0.15	0.01	0.31	0.06	0.25	0.01
Congo, Dem. Rep. of	0.90	0.70	0.89	-0.23	0.04	0.20	0.23	-0.02	0.00
Memo:									
AFRICA	0.99	0.89	0.94	-0.08	0.02	0.10	0.12	-0.04	0.01

We present the predicted increase in the growth rate of output per worker in 2001–5 relative to 1991–5 due to changes in the stock and quality of infrastructure (see table 3) and the decomposition of the contribution of stock and quality in the different dimensions of infrastructure considered in our analysis. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2.
Source: Author's calculations.

Table 5. Growth changes due to infrastructure development in Africa, 2001–5 versus 1991–5, Using IK2 index of aggregate infrastructure stocks

Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
Explaining change in the growth rate of real GDP per capita across African countries

Country	Infrastructure development	Infrastructure stock				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	0.40	0.14	0.11	0.02	0.01	0.26	0.24	-0.03	0.05
Algeria	0.08	0.01	0.07	-0.07	0.02	0.06	0.03	-0.01	0.04
Egypt	0.91	0.33	0.25	0.03	0.04	0.58	0.49	-0.07	0.16
Libya	0.32	0.06	0.14	-0.10	0.02	0.26	0.25	-0.01	0.02
Morocco	0.25	0.16	0.05	0.09	0.01	0.09	0.22	-0.15	0.02
Tunisia	0.42	0.14	0.17	0.10	-0.13	0.28	0.21	-0.03	0.10
West Africa (ECOWAS)	0.14	0.16	0.23	-0.05	-0.02	-0.02	-0.02	0.01	0.00
Benin	0.60	0.36	0.21	0.38	-0.24	0.25	-0.09	0.30	0.04
Burkina Faso	0.39	0.28	0.20	0.13	-0.04	0.11	0.13	-0.01	-0.01
Côte d'Ivoire	0.58	0.03	0.20	-0.12	-0.04	0.54	0.59	-0.05	0.00
Ghana	-0.24	0.28	0.35	-0.03	-0.04	-0.52	-0.18	-0.39	0.04
Guinea	0.54	0.22	0.16	0.05	0.01	0.31	0.37	-0.03	-0.02
Gambia	0.16	0.07	0.14	-0.06	-0.01	0.09	0.06	-0.01	0.04
Guinea-Bissau	-0.04	0.16	0.05	0.10	0.01	-0.20	-0.23	0.02	0.01
Mauritania	-0.21	0.21	0.28	-0.05	-0.02	-0.42	-0.46	0.04	0.00
Niger	-0.16	-0.05	0.10	0.05	-0.20	-0.11	0.03	0.01	-0.15
Nigeria	0.11	0.13	0.14	-0.06	0.05	-0.02	-0.02	0.00	-0.01
Senegal	0.31	0.20	0.25	-0.06	0.01	0.11	0.24	-0.12	-0.01
Sierra Leone	-0.04	0.06	0.07	-0.04	0.03	-0.10	0.00	0.01	-0.11
Togo	-0.50	0.05	0.20	-0.13	-0.03	-0.54	-0.03	-0.55	0.03
East Africa (EAC)	0.23	0.10	0.09	0.01	0.00	0.13	0.01	0.14	-0.02
Burundi	0.23	0.10	0.08	0.00	0.03	0.13	0.01	0.08	0.04
Kenya	-0.21	0.01	0.02	0.01	-0.02	-0.22	-0.41	0.20	-0.02
Rwanda	0.03	-0.11	0.11	-0.10	-0.11	0.14	0.00	0.13	0.00
Tanzania	0.35	0.17	0.09	0.08	0.00	0.18	-0.20	0.31	0.07
Uganda	0.21	0.22	0.12	0.09	0.01	-0.01	-0.01	0.00	0.00
Southern Africa (SADC)	0.29	0.14	0.13	-0.07	0.08	0.15	0.20	-0.07	0.02
Angola	0.19	-0.14	0.05	-0.06	-0.12	0.33	0.31	-0.03	0.05
Botswana	0.64	0.31	0.26	-0.16	0.21	0.33	0.50	-0.03	-0.14
Madagascar	0.25	0.02	0.05	-0.07	0.04	0.22	-0.02	0.16	0.09
Mauritius	0.88	0.42	0.25	0.15	0.02	0.47	0.07	0.39	0.01
Malawi	0.39	0.35	0.16	0.05	0.13	0.04	0.02	0.01	0.01
South Africa	0.01	0.17	0.02	-0.01	0.16	-0.16	-0.01	-0.16	0.01
Zambia	0.09	0.01	-0.02	-0.06	0.09	0.08	0.09	-0.01	-0.01
Zimbabwe	-0.23	0.11	0.15	-0.05	0.01	-0.34	-0.36	0.03	-0.01
Central Africa	0.21	0.09	0.12	-0.06	0.02	0.12	0.15	-0.03	0.00
Central African Republic	0.28	-0.03	0.04	-0.07	0.00	0.32	-0.02	0.35	-0.01
Cameroon	-0.07	0.18	0.10	0.04	0.04	-0.25	0.09	-0.34	0.00
Congo, Rep. of	-0.66	-0.22	-0.14	-0.08	-0.01	-0.43	-0.62	0.00	0.19
Ethiopia	0.27	0.23	0.19	0.02	0.02	0.04	0.03	0.01	0.00
Gabon	-0.18	0.08	-0.01	0.01	0.09	-0.26	-0.31	0.02	0.02
Sudan	0.97	0.57	0.54	0.06	-0.02	0.40	0.34	-0.03	0.09
Chad	0.39	0.09	0.16	-0.07	0.00	0.29	0.06	0.23	0.01
Congo, Dem. Rep. of	-0.26	-0.45	-0.36	-0.11	0.02	0.19	0.21	-0.02	0.00
Memo:									
AFRICA	0.22	0.13	0.15	-0.04	0.01	0.09	0.12	-0.03	0.01

We present the predicted increase in the growth rate of output per worker in 2001–5 relative to 1991–5 due to changes in the stock and quality of infrastructure (see table 3) and the decomposition of the contribution of stock and quality in the different dimensions of infrastructure considered in our analysis. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2.
Source: Author's calculations.

Table 6. Potential growth improvements across African regions due to better growth fundamentals, Using IK1 index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(Calculations based on 2001–5 average data)

Variable	Growth change		Transitional	Structural	Stabilization	External	Infrastructure development		
	Actual	Predicted	convergence	policies	policies	factors	Total	Stock	Quality
Scenario 1: Reaching the African leader 1/									
North Africa	6.43	**2.42**	-3.14	1.63	1.47	0.76	**1.70**	1.20	0.50
West Africa	7.79	**3.19**	-8.78	4.34	1.57	0.88	**5.19**	4.06	1.13
East Africa	7.40	**3.73**	-9.34	4.51	1.81	1.05	**5.70**	4.41	1.30
Southern Africa	7.56	**3.45**	-5.91	3.19	2.23	0.90	**3.04**	2.25	0.79
Central Africa	6.91	**3.96**	-7.96	5.00	1.17	0.61	**5.14**	3.91	1.23
AFRICA	7.34	**3.36**	-7.37	3.90	1.64	0.84	**4.36**	3.33	1.02
Scenario 2: Reaching the East Asian representative country 2/									
North Africa	0.49	**0.36**	-4.58	1.44	0.50	-0.20	**3.20**	2.22	0.98
West Africa	1.85	**1.13**	-10.22	4.15	0.60	-0.08	**6.68**	5.08	1.60
East Africa	1.47	**1.67**	-10.78	4.32	0.84	0.09	**7.20**	5.43	1.77
Southern Africa	1.62	**1.38**	-7.35	3.00	1.27	-0.06	**4.53**	3.27	1.25
Central Africa	0.97	**1.90**	-9.40	4.81	0.21	-0.35	**6.64**	4.93	1.71
AFRICA	1.40	**1.30**	-8.81	3.71	0.68	-0.12	**5.85**	4.35	1.49
Scenario 3: Reaching the leader in East Asia 2/									
North Africa	1.23	**2.74**	-6.94	1.89	1.27	-0.07	**6.60**	5.16	1.44
West Africa	2.59	**3.50**	-12.58	4.59	1.37	0.05	**10.08**	8.02	2.07
East Africa	2.21	**4.05**	-13.14	4.76	1.61	0.22	**10.60**	8.36	2.24
Southern Africa	2.36	**3.76**	-9.71	3.44	2.03	0.07	**7.93**	6.21	1.72
Central Africa	1.71	**4.28**	-11.76	5.25	0.97	-0.22	**10.04**	7.87	2.17
AFRICA	2.14	**3.67**	-11.17	4.15	1.44	0.01	**9.25**	7.29	1.96
Scenario 4: Reaching the representative country in Western Europe 3/									
North Africa	-1.48	**-0.97**	-6.75	2.59	-0.43	-0.10	**3.73**	2.50	1.23
West Africa	-0.12	**-0.20**	-12.39	5.29	-0.33	0.02	**7.22**	5.36	1.85
East Africa	-0.50	**0.34**	-12.95	5.46	-0.09	0.19	**7.73**	5.71	2.02
Southern Africa	-0.34	**0.05**	-9.52	4.14	0.34	0.04	**5.06**	3.56	1.50
Central Africa	-1.00	**0.57**	-11.57	5.95	-0.72	-0.25	**7.17**	5.21	1.96
AFRICA	-0.57	**-0.03**	-10.99	4.85	-0.26	-0.02	**6.38**	4.64	1.74
Scenario 5: Reaching the leader in Western Europe 3/									
North Africa	0.94	**-0.55**	-8.54	2.66	0.44	-0.03	**4.91**	3.48	1.43
West Africa	2.30	**0.22**	-14.18	5.37	0.55	0.09	**8.40**	6.34	2.06
East Africa	1.92	**0.76**	-14.73	5.54	0.79	0.26	**8.91**	6.69	2.23
Southern Africa	2.07	**0.48**	-11.31	4.22	1.21	0.11	**6.25**	4.54	1.71
Central Africa	1.42	**0.99**	-13.35	6.03	0.15	-0.18	**8.35**	6.19	2.16
AFRICA	1.85	**0.39**	-12.77	4.92	0.62	0.05	**7.57**	5.62	1.95

The figures presented in table 7 represent the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of growth determinants were to reach the 2001–5 average levels of a specific benchmark country / region. In our case, the benchmark is the African leader, the South Asian leader, and the representative (median) country of East Asia and Western Europe. For these calculations we use the [IK1] index of aggregate infrastructure stocks and the regression [IK1] in table 2.
1/ The leader in infrastructure stocks and quality in the Africa region are South Africa and Mauritius, respectively. 2/ Korea and Hong Kong represent the median in stocks and quality of infrastructure, respectively, while Singapore and Taiwan are the leaders of EAP7. 3/ The representative countries in Western Europe in infrastructure development are the United Kingdom (stock and quality) and Ireland (quality). On the other hand, Norway and Germany are the leaders in quantity and quality, respectively.
Source: Author's calculations.

Table 7. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 1: Reaching the level of infrastructure development of the leader in Africa, using IK1 index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(percent)

Country	Infrastructure development	Infrastructure stocks				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	1.70	1.20	0.17	0.35	0.67	0.50	0.19	0.34	-0.02
Algeria	2.58	1.78	0.47	0.61	0.71	0.80	0.63	0.36	-0.18
Egypt	0.92	0.85	0.06	0.35	0.44	0.07	-0.01	0.16	-0.09
Libya	1.07	0.05	0.28	-0.21	-0.02	1.02	0.19	0.84	-0.01
Morocco	2.01	1.75	0.01	0.64	1.09	0.26	-0.04	0.21	0.10
Tunisia	1.93	1.56	0.03	0.38	1.15	0.37	0.18	0.12	0.07
West Africa (ECOWAS)	5.19	4.06	1.08	1.88	1.10	1.13	0.23	0.51	0.39
Benin	5.41	4.79	0.98	2.02	1.79	0.62	0.02	0.69	-0.08
Burkina Faso	6.31	5.24	1.29	2.18	1.77	1.08	0.32	0.34	0.42
Côte d'Ivoire	3.39	2.57	0.51	1.38	0.68	0.82	-0.02	0.36	0.49
Ghana	4.14	3.11	0.90	1.32	0.89	1.02	0.35	0.39	0.28
Guinea	3.96	3.36	1.56	1.74	0.07	0.60	-0.23	0.38	0.46
Gambia	4.26	3.03	0.57	1.97	0.48	1.23	0.52	0.32	0.40
Guinea-Bissau	5.97	4.65	1.72	2.09	0.84	1.32	0.52	0.31	0.49
Mauritania	4.00	2.67	0.45	1.57	0.66	1.33	0.55	0.31	0.46
Niger	7.95	6.89	1.95	2.42	2.52	1.06	0.20	0.34	0.52
Nigeria	5.63	3.67	1.08	1.36	1.22	1.96	0.44	1.25	0.27
Senegal	4.44	3.78	0.68	1.86	1.24	0.66	-0.68	0.78	0.56
Sierra Leone	5.12	3.70	1.44	1.78	0.47	1.43	0.62	0.31	0.50
Togo	6.86	5.30	0.93	2.68	1.68	1.57	0.45	0.87	0.25
East Africa (EAC)	5.70	4.41	1.28	2.26	0.86	1.30	0.36	0.47	0.46
Burundi	6.29	4.99	1.66	2.59	0.74	1.29	0.46	0.32	0.52
Kenya	4.72	3.25	0.83	1.68	0.74	1.47	0.52	0.52	0.43
Rwanda	6.53	5.19	1.46	2.87	0.85	1.35	0.53	0.31	0.50
Tanzania	5.06	3.72	1.26	1.93	0.53	1.33	0.12	0.73	0.49
Uganda	5.93	4.87	1.17	2.24	1.46	1.05	0.19	0.48	0.39
Southern Africa (SADC)	3.04	2.25	0.71	1.02	0.52	0.79	0.38	0.23	0.17
Angola	4.54	3.52	1.36	1.53	0.63	1.02	0.46	0.29	0.26
Botswana	1.36	0.77	-0.15	1.07	-0.14	0.59	0.01	0.38	0.20
Madagascar	5.02	4.25	1.45	2.22	0.58	0.78	-0.06	0.36	0.48
Mauritius	0.33	0.33	-0.29	0.13	0.50	0.00	0.02	0.43	-0.44
Malawi	5.61	4.33	1.44	1.93	0.96	1.28	0.54	0.32	0.42
South Africa	0.57	0.00	-0.18	-0.20	0.37	0.57	0.60	0.43	-0.47
Zambia	3.59	2.95	1.21	0.76	0.98	0.64	0.90	-0.83	0.58
Zimbabwe	3.29	1.87	0.84	0.76	0.26	1.42	0.55	0.50	0.36
Central Africa	5.14	3.91	1.17	1.76	0.98	1.23	0.35	0.42	0.46
Central African Republic	5.78	4.83	1.69	2.34	0.80	0.96	-0.02	0.37	0.61
Cameroon	4.45	2.82	0.75	1.31	0.77	1.63	0.51	0.65	0.47
Congo, Rep. of	4.47	2.59	0.56	1.72	0.31	1.88	0.00	1.49	0.39
Ethiopia	6.96	5.96	1.86	2.38	1.72	1.00	0.50	0.04	0.46
Gabon	2.17	0.69	0.08	0.40	0.21	1.48	0.59	0.41	0.48
Sudan	6.17	5.13	0.84	1.67	2.62	1.04	0.51	0.32	0.21
Chad	6.63	5.57	1.72	2.88	0.98	1.06	0.14	0.34	0.58
Congo, Dem. Rep. of	4.50	3.66	1.84	1.42	0.40	0.83	0.60	-0.28	0.52
Memo:									
AFRICA	4.36	3.33	0.93	1.53	0.87	1.02	0.30	0.41	0.32

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

Table 8. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 2: Reaching the representative country in East Asia (EAP7), using IK1 index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land) (percent)

Country	Infrastructure development	Infrastructure stocks				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	3.20	2.22	0.85	0.63	0.74	0.98	0.36	0.41	0.20
Algeria	4.08	2.80	1.15	0.89	0.77	1.27	0.80	0.44	0.04
Egypt	2.41	1.87	0.74	0.63	0.50	0.54	0.17	0.24	0.14
Libya	2.56	1.07	0.96	0.07	0.05	1.49	0.37	0.91	0.21
Morocco	3.50	2.77	0.69	0.92	1.15	0.74	0.13	0.28	0.32
Tunisia	3.42	2.58	0.71	0.66	1.21	0.84	0.35	0.20	0.29
West Africa (ECOWAS)	6.68	5.08	1.76	2.16	1.16	1.60	0.41	0.59	0.61
Benin	6.90	5.81	1.66	2.30	1.85	1.09	0.19	0.76	0.14
Burkina Faso	7.81	6.26	1.96	2.46	1.83	1.55	0.49	0.41	0.65
Côte d'Ivoire	4.89	3.59	1.19	1.66	0.74	1.30	0.15	0.43	0.71
Ghana	5.63	4.13	1.57	1.60	0.96	1.50	0.52	0.47	0.50
Guinea	5.46	4.38	2.23	2.02	0.13	1.07	-0.05	0.45	0.68
Gambia	5.75	4.05	1.25	2.25	0.54	1.71	0.69	0.40	0.62
Guinea-Bissau	7.47	5.67	2.40	2.37	0.90	1.80	0.70	0.39	0.71
Mauritania	5.50	3.69	1.12	1.85	0.72	1.80	0.73	0.39	0.68
Niger	9.44	7.91	2.62	2.70	2.58	1.53	0.38	0.41	0.74
Nigeria	7.12	4.69	1.76	1.64	1.29	2.43	0.61	1.32	0.49
Senegal	5.93	4.80	1.35	2.14	1.30	1.13	-0.51	0.86	0.78
Sierra Leone	6.62	4.72	2.12	2.06	0.53	1.90	0.79	0.38	0.73
Togo	8.36	6.32	1.61	2.96	1.75	2.04	0.62	0.95	0.47
East Africa (EAC)	7.20	5.43	1.95	2.54	0.93	1.77	0.54	0.55	0.69
Burundi	7.78	6.01	2.34	2.87	0.80	1.77	0.63	0.39	0.74
Kenya	6.21	4.27	1.50	1.96	0.81	1.94	0.70	0.60	0.65
Rwanda	8.03	6.21	2.14	3.15	0.92	1.82	0.71	0.39	0.72
Tanzania	6.55	4.74	1.94	2.21	0.59	1.81	0.29	0.81	0.71
Uganda	7.42	5.89	1.85	2.52	1.52	1.53	0.36	0.56	0.61
Southern Africa (SADC)	4.53	3.27	1.39	1.30	0.58	1.26	0.55	0.31	0.40
Angola	6.04	4.54	2.04	1.81	0.70	1.49	0.64	0.37	0.49
Botswana	2.86	1.79	0.52	1.35	-0.08	1.06	0.19	0.45	0.42
Madagascar	6.52	5.27	2.13	2.50	0.64	1.25	0.11	0.44	0.70
Mauritius	1.82	1.35	0.38	0.41	0.56	0.47	0.19	0.50	-0.22
Malawi	7.10	5.35	2.12	2.21	1.03	1.75	0.71	0.40	0.64
South Africa	2.06	1.02	0.50	0.08	0.44	1.04	0.78	0.51	-0.24
Zambia	5.09	3.97	1.89	1.04	1.04	1.12	1.08	-0.76	0.80
Zimbabwe	4.78	2.89	1.52	1.04	0.33	1.89	0.73	0.58	0.59
Central Africa	6.64	4.93	1.84	2.04	1.04	1.71	0.53	0.49	0.69
Central African Republic	7.28	5.85	2.37	2.62	0.86	1.43	0.16	0.45	0.83
Cameroon	5.95	3.84	1.42	1.59	0.83	2.10	0.68	0.73	0.69
Congo, Rep. of	5.96	3.61	1.23	2.00	0.38	2.36	0.17	1.57	0.61
Ethiopia	8.46	6.98	2.54	2.66	1.79	1.47	0.68	0.12	0.68
Gabon	3.66	1.71	0.76	0.68	0.27	1.95	0.77	0.49	0.70
Sudan	7.66	6.15	1.52	1.95	2.68	1.51	0.68	0.40	0.43
Chad	8.13	6.60	2.39	3.16	1.04	1.53	0.31	0.42	0.80
Congo, Dem. Rep. of	5.99	4.68	2.52	1.70	0.47	1.31	0.77	-0.21	0.74
Memo:									
AFRICA	5.85	4.35	1.61	1.81	0.93	1.50	0.47	0.48	0.54

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.

Source: Author's calculations.

Table 9. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 3: Reaching the country leader in East Asia (EAP7), using IK1 index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megwatts per 1,000 workers), total roads (km. per sq. km. of arable land) (percent)

	Infrastructure	Infrastructure stocks				Infrastructure quality			
Country	development	Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	6.60	5.16	0.90	0.79	3.47	1.44	0.48	0.60	0.36
Algeria	7.48	5.74	1.20	1.04	3.50	1.74	0.92	0.62	0.20
Egypt	5.81	4.81	0.79	0.79	3.23	1.00	0.28	0.42	0.30
Libya	5.96	4.01	1.01	0.22	2.77	1.95	0.49	1.09	0.37
Morocco	6.90	5.71	0.74	1.08	3.88	1.20	0.25	0.47	0.48
Tunisia	6.82	5.52	0.77	0.81	3.94	1.30	0.47	0.38	0.45
West Africa (ECOWAS)	10.08	8.02	1.81	2.31	3.89	2.07	0.53	0.77	0.77
Benin	10.31	8.75	1.71	2.45	4.58	1.56	0.31	0.95	0.30
Burkina Faso	11.21	9.20	2.02	2.61	4.56	2.01	0.61	0.59	0.81
Côte d'Ivoire	8.29	6.53	1.24	1.81	3.47	1.76	0.27	0.62	0.88
Ghana	9.03	7.07	1.63	1.76	3.69	1.96	0.64	0.65	0.67
Guinea	8.86	7.32	2.29	2.17	2.86	1.54	0.06	0.63	0.84
Gambia	9.15	6.98	1.30	2.41	3.27	2.17	0.81	0.58	0.78
Guinea-Bissau	10.87	8.61	2.45	2.52	3.63	2.26	0.81	0.57	0.87
Mauritania	8.90	6.63	1.18	2.00	3.45	2.27	0.84	0.57	0.85
Niger	12.84	10.85	2.68	2.86	5.31	1.99	0.49	0.60	0.90
Nigeria	10.52	7.63	1.82	1.79	4.02	2.89	0.73	1.51	0.66
Senegal	9.33	7.73	1.41	2.29	4.03	1.60	-0.39	1.04	0.95
Sierra Leone	10.02	7.65	2.18	2.22	3.26	2.36	0.91	0.57	0.89
Togo	11.76	9.26	1.67	3.11	4.48	2.50	0.74	1.13	0.63
East Africa (EAC)	10.60	8.36	2.01	2.70	3.66	2.24	0.66	0.73	0.85
Burundi	11.18	8.95	2.40	3.02	3.53	2.23	0.75	0.58	0.90
Kenya	9.61	7.21	1.56	2.11	3.54	2.41	0.82	0.78	0.81
Rwanda	11.43	9.15	2.20	3.30	3.65	2.28	0.83	0.57	0.88
Tanzania	9.95	7.68	2.00	2.37	3.32	2.27	0.41	0.99	0.87
Uganda	10.82	8.83	1.90	2.68	4.25	1.99	0.48	0.74	0.77
Southern Africa (SADC)	7.93	6.21	1.44	1.46	3.31	1.72	0.67	0.49	0.56
Angola	9.44	7.48	2.10	1.96	3.43	1.95	0.75	0.55	0.65
Botswana	6.26	4.73	0.58	1.50	2.65	1.52	0.30	0.64	0.59
Madagascar	9.92	8.21	2.19	2.65	3.37	1.71	0.23	0.62	0.86
Mauritius	5.22	4.29	0.44	0.56	3.29	0.94	0.31	0.69	-0.06
Malawi	10.50	8.29	2.17	2.36	3.75	2.21	0.83	0.58	0.80
South Africa	5.46	3.96	0.56	0.24	3.17	1.50	0.89	0.69	-0.08
Zambia	8.49	6.91	1.94	1.19	3.77	1.58	1.19	-0.57	0.96
Zimbabwe	8.18	5.83	1.58	1.19	3.06	2.35	0.84	0.76	0.75
Central Africa	10.04	7.87	1.90	2.20	3.77	2.17	0.64	0.68	0.85
Central African Republic	10.68	8.79	2.42	2.77	3.59	1.89	0.27	0.63	0.99
Cameroon	9.35	6.78	1.48	1.74	3.56	2.57	0.80	0.91	0.86
Congo, Rep. of	9.36	6.54	1.29	2.15	3.11	2.82	0.29	1.75	0.78
Ethiopia	11.86	9.92	2.59	2.81	4.52	1.94	0.79	0.30	0.84
Gabon	7.07	4.65	0.82	0.84	3.00	2.41	0.88	0.67	0.86
Sudan	11.06	9.09	1.57	2.10	5.41	1.97	0.80	0.58	0.60
Chad	11.53	9.53	2.45	3.31	3.77	1.99	0.43	0.60	0.97
Congo, Dem. Rep. of	9.39	7.62	2.58	1.85	3.20	1.77	0.89	-0.02	0.90
Memo:									
AFRICA	9.25	7.29	1.66	1.97	3.66	1.96	0.59	0.67	0.70

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.

Source: Author's calculations.

Table 10. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 4: Reaching the representative country in Western Europe (EUR), using IK1 index of aggregate infrastructure stocks
Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land) (percent)

Country	Infrastructure development	Infrastructure stocks				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	3.73	2.50	0.87	0.75	0.88	1.23	0.45	0.45	0.32
Algeria	4.61	3.09	1.17	1.00	0.92	1.52	0.89	0.47	0.16
Egypt	2.95	2.16	0.76	0.75	0.65	0.79	0.26	0.27	0.26
Libya	3.09	1.35	0.98	0.18	0.19	1.74	0.46	0.95	0.33
Morocco	4.04	3.05	0.71	1.04	1.30	0.99	0.22	0.32	0.45
Tunisia	3.96	2.87	0.73	0.78	1.36	1.09	0.44	0.24	0.41
West Africa (ECOWAS)	7.22	5.36	1.78	2.27	1.31	1.85	0.50	0.62	0.73
Benin	7.44	6.09	1.68	2.42	2.00	1.34	0.28	0.80	0.26
Burkina Faso	8.34	6.54	1.98	2.58	1.98	1.80	0.58	0.45	0.77
Côte d'Ivoire	5.42	3.87	1.21	1.78	0.89	1.55	0.24	0.47	0.84
Ghana	6.16	4.42	1.59	1.72	1.10	1.75	0.61	0.51	0.63
Guinea	5.99	4.67	2.25	2.13	0.28	1.32	0.03	0.49	0.80
Gambia	6.29	4.33	1.27	2.37	0.69	1.96	0.78	0.44	0.74
Guinea-Bissau	8.00	5.95	2.42	2.49	1.05	2.05	0.78	0.43	0.83
Mauritania	6.03	3.98	1.14	1.97	0.87	2.05	0.82	0.43	0.81
Niger	9.97	8.19	2.64	2.82	2.73	1.78	0.46	0.45	0.87
Nigeria	7.65	4.97	1.78	1.76	1.43	2.68	0.70	1.36	0.62
Senegal	6.46	5.08	1.37	2.25	1.45	1.38	-0.42	0.89	0.91
Sierra Leone	7.15	5.00	2.14	2.18	0.68	2.15	0.88	0.42	0.85
Togo	8.89	6.60	1.63	3.08	1.89	2.29	0.71	0.98	0.59
East Africa (EAC)	7.73	5.71	1.97	2.66	1.08	2.02	0.63	0.58	0.81
Burundi	8.31	6.30	2.36	2.99	0.95	2.02	0.72	0.43	0.86
Kenya	6.75	4.55	1.52	2.07	0.96	2.19	0.79	0.63	0.77
Rwanda	8.56	6.49	2.16	3.26	1.06	2.07	0.80	0.43	0.85
Tanzania	7.08	5.03	1.96	2.33	0.74	2.06	0.38	0.84	0.83
Uganda	7.95	6.18	1.86	2.64	1.67	1.78	0.45	0.59	0.73
Southern Africa (SADC)	5.06	3.56	1.41	1.42	0.73	1.51	0.64	0.35	0.52
Angola	6.57	4.83	2.06	1.92	0.84	1.74	0.73	0.41	0.61
Botswana	3.39	2.08	0.54	1.47	0.07	1.31	0.27	0.49	0.55
Madagascar	7.05	5.55	2.15	2.61	0.79	1.50	0.20	0.47	0.82
Mauritius	2.35	1.63	0.40	0.52	0.71	0.72	0.28	0.54	-0.10
Malawi	7.63	5.63	2.14	2.32	1.17	2.00	0.80	0.43	0.77
South Africa	2.59	1.30	0.52	0.20	0.58	1.29	0.87	0.55	-0.12
Zambia	5.62	4.25	1.91	1.16	1.19	1.37	1.17	-0.72	0.92
Zimbabwe	5.31	3.17	1.54	1.16	0.47	2.14	0.82	0.62	0.71
Central Africa	7.17	5.21	1.86	2.16	1.19	1.96	0.62	0.53	0.81
Central African Republic	7.81	6.13	2.39	2.74	1.01	1.68	0.25	0.48	0.95
Cameroon	6.48	4.13	1.44	1.71	0.98	2.35	0.77	0.76	0.82
Congo, Rep. of	6.50	3.89	1.25	2.11	0.52	2.61	0.26	1.61	0.74
Ethiopia	8.99	7.26	2.56	2.77	1.93	1.72	0.77	0.16	0.80
Gabon	4.20	2.00	0.78	0.80	0.42	2.20	0.86	0.52	0.82
Sudan	8.19	6.43	1.54	2.06	2.83	1.76	0.77	0.43	0.56
Chad	8.66	6.88	2.41	3.28	1.19	1.78	0.40	0.45	0.93
Congo, Dem. Rep. of	6.52	4.96	2.54	1.81	0.61	1.56	0.86	-0.17	0.87
Memo:									
AFRICA	6.38	4.64	1.63	1.93	1.08	1.75	0.56	0.52	0.66

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

Table 11. Potential growth improvement in African Countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 5: Reaching the country leader in Western Europe, using IK1 index of aggregate infrastructure stocks

Main telephone lines and mobile phones (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land) (percent)

Country	Infrastructure development	Infrastructure stocks				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	4.91	3.48	0.81	1.29	1.38	1.43	0.48	0.59	0.36
Algeria	5.79	4.07	1.11	1.55	1.41	1.73	0.92	0.61	0.20
Egypt	4.13	3.14	0.70	1.29	1.14	0.99	0.28	0.41	0.30
Libya	4.28	2.33	0.92	0.73	0.69	1.94	0.48	1.09	0.37
Morocco	5.22	4.03	0.65	1.58	1.80	1.19	0.25	0.46	0.48
Tunisia	5.14	3.85	0.67	1.32	1.85	1.29	0.47	0.38	0.45
West Africa (ECOWAS)	8.40	6.34	1.72	2.82	1.81	2.06	0.52	0.76	0.77
Benin	8.62	7.07	1.62	2.96	2.49	1.55	0.31	0.94	0.30
Burkina Faso	9.52	7.52	1.93	3.12	2.47	2.00	0.61	0.59	0.81
Côte d'Ivoire	6.60	4.85	1.15	2.32	1.38	1.75	0.27	0.61	0.87
Ghana	7.35	5.40	1.54	2.26	1.60	1.95	0.64	0.65	0.66
Guinea	7.17	5.65	2.20	2.68	0.77	1.53	0.06	0.63	0.84
Gambia	7.47	5.31	1.21	2.91	1.18	2.16	0.81	0.58	0.78
Guinea-Bissau	9.18	6.94	2.36	3.03	1.55	2.25	0.81	0.57	0.87
Mauritania	7.21	4.96	1.09	2.51	1.36	2.26	0.84	0.57	0.85
Niger	11.16	9.17	2.59	3.36	3.22	1.98	0.49	0.59	0.90
Nigeria	8.84	5.95	1.72	2.30	1.93	2.88	0.73	1.50	0.65
Senegal	7.65	6.06	1.32	2.80	1.95	1.59	-0.39	1.03	0.95
Sierra Leone	8.33	5.98	2.08	2.72	1.17	2.35	0.91	0.56	0.89
Togo	10.07	7.58	1.57	3.62	2.39	2.49	0.74	1.12	0.63
East Africa (EAC)	8.91	6.69	1.92	3.20	1.57	2.23	0.65	0.73	0.85
Burundi	9.50	7.28	2.30	3.53	1.44	2.22	0.75	0.57	0.90
Kenya	7.93	5.53	1.47	2.62	1.45	2.40	0.81	0.77	0.81
Rwanda	9.74	7.47	2.10	3.81	1.56	2.27	0.82	0.57	0.88
Tanzania	8.27	6.01	1.90	2.87	1.23	2.26	0.41	0.98	0.87
Uganda	9.14	7.16	1.81	3.18	2.17	1.98	0.48	0.73	0.77
Southern Africa (SADC)	6.25	4.54	1.35	1.96	1.22	1.71	0.67	0.49	0.56
Angola	7.75	5.81	2.00	2.47	1.34	1.95	0.75	0.55	0.65
Botswana	4.57	3.06	0.49	2.01	0.56	1.52	0.30	0.63	0.58
Madagascar	8.23	6.53	2.09	3.16	1.28	1.70	0.23	0.61	0.86
Mauritius	3.54	2.61	0.34	1.07	1.20	0.93	0.31	0.68	-0.06
Malawi	8.82	6.61	2.08	2.87	1.67	2.20	0.83	0.57	0.80
South Africa	3.78	2.28	0.46	0.74	1.08	1.49	0.89	0.69	-0.08
Zambia	6.80	5.23	1.85	1.70	1.68	1.57	1.19	-0.58	0.96
Zimbabwe	6.50	4.15	1.48	1.70	0.97	2.34	0.84	0.76	0.75
Central Africa	8.35	6.19	1.81	2.70	1.68	2.16	0.64	0.67	0.85
Central African Republic	8.99	7.11	2.33	3.28	1.50	1.88	0.27	0.62	0.99
Cameroon	7.66	5.11	1.38	2.25	1.47	2.56	0.80	0.90	0.85
Congo, Rep. of	7.68	4.87	1.20	2.66	1.02	2.81	0.29	1.75	0.77
Ethiopia	10.17	8.24	2.50	3.32	2.43	1.93	0.79	0.30	0.84
Gabon	5.38	2.98	0.72	1.34	0.91	2.40	0.88	0.66	0.86
Sudan	9.38	7.41	1.48	2.61	3.33	1.96	0.80	0.57	0.59
Chad	9.84	7.86	2.36	3.82	1.68	1.99	0.43	0.59	0.96
Congo, Dem. Rep. of	7.71	5.95	2.48	2.36	1.11	1.76	0.89	-0.03	0.90
Memo:									
Africa Region	7.57	5.62	1.57	2.47	1.57	1.95	0.59	0.66	0.70

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.

Source: Author's calculations.

Table 12. Potential growth improvements across African regions due to better growth fundamentals, using IK2 index of aggregate infrastructure stocks

Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(Calculations based on 2001–5 average data)

Variable	Growth change: Actual	Growth change: Predicted	Transitional convergence	Structural policies	Stabilization policies	External factors	Infrastructure development: Total	Infrastructure development: Stock	Infrastructure development: Quality
Scenario 1: Reaching the African leader 1/									
North Africa	6.43	**2.80**	-2.27	1.30	1.83	0.74	**1.21**	0.87	0.34
West Africa	7.79	**4.34**	-5.26	3.85	1.79	0.93	**3.03**	2.02	1.01
East Africa	7.40	**5.43**	-5.70	4.33	2.08	0.81	**3.90**	2.65	1.25
Southern Africa	7.56	**4.10**	-4.07	3.23	1.91	1.02	**2.00**	1.34	0.66
Central Africa	6.91	**4.45**	-5.29	4.52	1.29	0.42	**3.52**	2.54	0.98
AFRICA	7.34	**4.34**	-5.03	3.75	1.81	0.90	**2.91**	1.94	0.97
Scenario 2: Reaching the representative country in East Asia 2/									
North Africa	0.49	**0.36**	-3.17	1.05	0.68	-0.22	**2.01**	1.23	0.79
West Africa	1.85	**1.90**	-6.16	3.61	0.65	-0.03	**3.83**	2.38	1.45
East Africa	1.47	**2.99**	-6.59	4.09	0.93	-0.14	**4.70**	3.01	1.69
Southern Africa	1.62	**1.66**	-4.96	2.99	0.77	0.07	**2.81**	1.70	1.11
Central Africa	0.97	**2.01**	-6.19	4.27	0.14	-0.53	**4.32**	2.89	1.43
AFRICA	1.40	**1.90**	-5.92	3.50	0.67	-0.06	**3.71**	2.30	1.42
Scenario 3: Reaching the leader in East Asia 3/									
North Africa	1.23	**2.38**	-4.63	1.71	1.58	-0.09	**3.81**	2.59	1.22
West Africa	2.59	**3.91**	-7.62	4.27	1.54	0.10	**5.62**	3.74	1.88
East Africa	2.21	**5.00**	-8.06	4.75	1.83	-0.02	**6.49**	4.37	2.13
Southern Africa	2.36	**3.67**	-6.43	3.65	1.66	0.19	**4.60**	3.06	1.54
Central Africa	1.71	**4.02**	-7.65	4.93	1.04	-0.41	**6.11**	4.25	1.86
AFRICA	2.14	**3.91**	-7.39	4.16	1.57	0.07	**5.51**	3.66	1.85
Scenario 4: Reaching the representative country in Western Europe 4/									
North Africa	-1.48	**-0.84**	-4.51	1.88	-0.44	-0.12	**2.35**	1.33	1.02
West Africa	-0.12	**0.70**	-7.50	4.44	-0.47	0.07	**4.17**	2.48	1.68
East Africa	-0.50	**1.79**	-7.94	4.92	-0.18	-0.05	**5.04**	3.11	1.93
Southern Africa	-0.34	**0.46**	-6.31	3.82	-0.35	0.16	**3.14**	1.80	1.34
Central Africa	-1.00	**0.81**	-7.53	5.10	-0.98	-0.44	**4.66**	3.00	1.66
AFRICA	-0.57	**0.70**	-7.27	4.33	-0.45	0.04	**4.05**	2.40	1.65
Scenario 5: Reaching the leader in Western Europe 4/									
North Africa	0.94	**0.27**	-5.62	2.29	0.60	-0.05	**3.04**	1.83	1.21
West Africa	2.30	**1.81**	-8.61	4.85	0.57	0.14	**4.86**	2.99	1.87
East Africa	1.92	**2.90**	-9.04	5.33	0.86	0.02	**5.73**	3.62	2.12
Southern Africa	2.07	**1.57**	-7.42	4.23	0.69	0.23	**3.84**	2.30	1.53
Central Africa	1.42	**1.92**	-8.64	5.51	0.06	-0.37	**5.35**	3.50	1.85
AFRICA	1.85	**1.81**	-8.38	4.74	0.59	0.11	**4.74**	2.90	1.84

The figures presented in table 7 represent the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of growth determinants were to reach the 2001–5 average levels of a specific benchmark country / region. In our case, the benchmark is the African leader, the South Asian leader, and the representative (median) country of East Asia and Western Europe. For these calculations we use the [IK1] index of aggregate infrastructure stocks and the regression [IK1] in table 2.
Source: Author's calculations.

Table 13. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 1: Reaching the infrastructure development of the leader in Africa, using IK2 index of aggregate infrastructure stocks
Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(percent)

Country	Infrastructure development	Infrastructure stocks				Infrastructure quality			
		Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	1.21	0.87	0.27	0.29	0.31	0.34	0.16	0.39	-0.21
Algeria	1.67	0.92	0.24	0.32	0.36	0.75	0.59	0.34	-0.17
Egypt	0.53	0.46	0.03	0.20	0.23	0.06	-0.01	0.15	-0.08
Libya	0.95	0.00	0.06	-0.07	0.01	0.95	0.18	0.78	-0.01
Morocco	1.47	1.23	0.29	0.33	0.60	0.25	-0.04	0.19	0.09
Tunisia	1.21	0.87	0.09	0.22	0.57	0.34	0.16	0.12	0.06
West Africa (ECOWAS)	3.03	2.02	0.71	0.88	0.43	1.01	0.32	0.31	0.38
Benin	3.17	2.59	0.72	1.00	0.87	0.58	0.02	0.64	-0.08
Burkina Faso	3.80	2.79	0.85	1.07	0.86	1.01	0.30	0.31	0.40
Côte d'Ivoire	2.32	1.55	0.54	0.66	0.34	0.77	-0.02	0.33	0.46
Ghana	2.70	1.74	0.64	0.66	0.44	0.96	0.33	0.37	0.26
Guinea	2.50	1.94	1.02	0.86	0.06	0.56	-0.22	0.35	0.43
Gambia	2.83	1.67	0.46	0.96	0.25	1.16	0.49	0.30	0.37
Guinea-Bissau	3.46	2.22	0.77	1.03	0.42	1.24	0.49	0.29	0.46
Mauritania	2.98	1.73	0.66	0.75	0.33	1.24	0.52	0.29	0.43
Niger	4.52	3.53	1.12	1.19	1.22	0.99	0.19	0.32	0.49
Nigeria	3.89	2.06	0.78	0.68	0.60	1.83	0.41	1.17	0.25
Senegal	2.64	2.02	0.50	0.92	0.61	0.62	-0.64	0.73	0.53
Sierra Leone	3.34	2.00	0.88	0.88	0.24	1.34	0.58	0.29	0.47
Togo	4.30	2.83	0.70	1.31	0.82	1.47	0.42	0.82	0.23
East Africa (EAC)	3.90	2.65	1.08	1.19	0.39	1.25	0.38	0.46	0.42
Burundi	3.86	2.65	1.01	1.27	0.37	1.21	0.43	0.30	0.49
Kenya	3.29	1.92	0.72	0.83	0.37	1.38	0.49	0.49	0.40
Rwanda	4.12	2.86	1.04	1.40	0.43	1.26	0.50	0.29	0.47
Tanzania	3.42	2.17	0.95	0.95	0.27	1.25	0.11	0.68	0.46
Uganda	3.85	2.87	1.05	1.10	0.71	0.99	0.18	0.45	0.36
Southern Africa (SADC)	2.00	1.34	0.61	0.46	0.27	0.66	0.19	0.23	0.25
Angola	2.87	1.92	0.84	0.76	0.32	0.95	0.43	0.27	0.25
Botswana	1.21	0.66	0.16	0.54	-0.05	0.55	0.01	0.35	0.19
Madagascar	3.09	2.36	0.98	1.09	0.30	0.73	-0.06	0.34	0.45
Mauritius	0.26	0.26	-0.08	0.09	0.26	0.00	0.02	0.40	-0.42
Malawi	3.47	2.27	0.84	0.95	0.48	1.20	0.50	0.30	0.39
South Africa	0.79	0.26	0.12	-0.07	0.20	0.53	0.56	0.40	-0.44
Zambia	2.24	1.63	0.76	0.39	0.48	0.60	0.84	-0.78	0.54
Zimbabwe	2.38	1.05	0.48	0.39	0.18	1.33	0.52	0.47	0.34
Central Africa	3.52	2.54	1.08	1.01	0.45	0.98	0.37	0.25	0.36
Central African Republic	3.51	2.61	1.06	1.15	0.40	0.90	-0.02	0.35	0.57
Cameroon	3.33	1.80	0.77	0.65	0.38	1.53	0.48	0.61	0.44
Congo, Rep. of	3.66	1.90	0.91	0.81	0.18	1.76	0.00	1.40	0.37
Ethiopia	3.81	2.88	0.86	1.17	0.84	0.94	0.47	0.04	0.43
Gabon	2.18	0.80	0.45	0.23	0.12	1.38	0.55	0.38	0.44
Sudan	3.48	2.51	0.41	0.83	1.27	0.97	0.47	0.30	0.20
Chad	4.05	3.06	1.16	1.41	0.49	0.99	0.13	0.32	0.54
Congo, Dem. Rep. of	3.34	2.56	1.64	0.71	0.21	0.78	0.56	-0.26	0.49
Memo:									
Africa Region	2.91	1.94	0.75	0.82	0.37	0.97	0.31	0.30	0.37

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

Table 14. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 2: Reaching the representative country in East Asia (EAP7), using IK2 index of aggregate infrastructure stocks
Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(percent)

	Infrastructure	Infrastructure stocks				Infrastructure quality			
Country	**development**	**Total**	**Telecom**	**Electricity**	**Roads**	**Total**	**Telecom**	**Electricity**	**Roads**
North Africa	2.01	1.23	0.49	0.41	0.33	0.79	0.33	0.46	0.00
Algeria	2.47	1.27	0.46	0.44	0.38	1.19	0.75	0.41	0.03
Egypt	1.33	0.82	0.26	0.32	0.25	0.51	0.16	0.22	0.13
Libya	1.75	0.36	0.28	0.05	0.03	1.39	0.35	0.85	0.19
Morocco	2.27	1.58	0.52	0.45	0.62	0.69	0.12	0.27	0.30
Tunisia	2.01	1.23	0.31	0.33	0.58	0.79	0.33	0.19	0.27
West Africa (ECOWAS)	3.83	2.38	0.93	1.00	0.45	1.45	0.48	0.38	0.59
Benin	3.97	2.95	0.94	1.12	0.89	1.02	0.18	0.72	0.13
Burkina Faso	4.60	3.15	1.08	1.19	0.88	1.45	0.46	0.39	0.60
Côte d'Ivoire	3.12	1.91	0.77	0.78	0.36	1.22	0.14	0.41	0.67
Ghana	3.50	2.10	0.86	0.78	0.46	1.40	0.49	0.44	0.47
Guinea	3.30	2.30	1.25	0.98	0.08	1.01	-0.05	0.42	0.63
Gambia	3.63	2.03	0.68	1.08	0.27	1.60	0.65	0.37	0.58
Guinea-Bissau	4.26	2.58	0.99	1.15	0.44	1.68	0.65	0.37	0.66
Mauritania	3.78	2.09	0.88	0.87	0.35	1.69	0.68	0.37	0.64
Niger	5.32	3.89	1.34	1.31	1.24	1.43	0.35	0.39	0.69
Nigeria	4.69	2.42	1.00	0.80	0.62	2.28	0.58	1.24	0.46
Senegal	3.44	2.38	0.72	1.04	0.63	1.06	-0.47	0.80	0.73
Sierra Leone	4.14	2.36	1.10	1.00	0.26	1.78	0.74	0.36	0.68
Togo	5.10	3.19	0.92	1.43	0.84	1.91	0.58	0.89	0.44
East Africa (EAC)	4.70	3.01	1.30	1.31	0.40	1.69	0.54	0.53	0.62
Burundi	4.67	3.01	1.23	1.39	0.39	1.66	0.59	0.37	0.69
Kenya	4.09	2.27	0.94	0.95	0.39	1.82	0.65	0.56	0.61
Rwanda	4.93	3.22	1.26	1.52	0.44	1.70	0.66	0.36	0.67
Tanzania	4.22	2.53	1.17	1.07	0.29	1.69	0.28	0.75	0.66
Uganda	4.66	3.23	1.27	1.22	0.73	1.43	0.34	0.52	0.57
Southern Africa (SADC)	2.81	1.70	0.83	0.58	0.29	1.11	0.35	0.30	0.46
Angola	3.67	2.28	1.06	0.88	0.34	1.40	0.60	0.35	0.45
Botswana	2.01	1.02	0.38	0.66	-0.03	1.00	0.17	0.42	0.40
Madagascar	3.89	2.72	1.20	1.21	0.31	1.17	0.11	0.41	0.65
Mauritius	1.07	0.62	0.14	0.21	0.27	0.44	0.18	0.47	-0.21
Malawi	4.27	2.63	1.06	1.07	0.50	1.64	0.67	0.37	0.60
South Africa	1.59	0.61	0.34	0.05	0.22	0.97	0.73	0.48	-0.23
Zambia	3.04	1.99	0.98	0.51	0.50	1.05	1.01	-0.71	0.75
Zimbabwe	3.18	1.41	0.70	0.51	0.19	1.77	0.68	0.54	0.55
Central Africa	4.32	2.89	1.30	1.13	0.46	1.43	0.53	0.33	0.57
Central African Republic	4.31	2.97	1.28	1.27	0.42	1.34	0.15	0.42	0.77
Cameroon	4.13	2.16	1.00	0.77	0.40	1.97	0.64	0.68	0.65
Congo, Rep. of	4.46	2.26	1.13	0.93	0.20	2.21	0.16	1.47	0.57
Ethiopia	4.61	3.23	1.08	1.29	0.86	1.38	0.63	0.11	0.64
Gabon	2.98	1.16	0.67	0.35	0.14	1.83	0.72	0.46	0.65
Sudan	4.28	2.87	0.64	0.95	1.28	1.42	0.64	0.37	0.41
Chad	4.85	3.41	1.38	1.53	0.50	1.43	0.29	0.39	0.75
Congo, Dem. Rep. of	4.14	2.92	1.86	0.83	0.23	1.22	0.72	-0.19	0.69
Memo:									
Africa Region	3.71	2.30	0.97	0.94	0.39	1.42	0.47	0.37	0.58

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

Table 15. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 3: Reaching the country leader in East Asia (EAP7), using IK2 index of aggregate infrastructure stocks

Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(percent)

	Infrastructure	Infrastructure stocks				Infrastructure quality			
Country	development	Total	Telecom	Electricity	Roads	Total	Telecom	Electricity	Roads
North Africa	3.81	2.59	0.50	0.47	1.62	1.22	0.44	0.63	0.15
Algeria	4.26	2.63	0.47	0.50	1.67	1.63	0.86	0.58	0.19
Egypt	3.12	2.18	0.27	0.38	1.54	0.94	0.27	0.39	0.28
Libya	3.54	1.72	0.29	0.10	1.32	1.83	0.46	1.03	0.35
Morocco	4.07	2.94	0.53	0.51	1.91	1.12	0.23	0.44	0.45
Tunisia	3.81	2.59	0.32	0.39	1.87	1.22	0.44	0.36	0.42
West Africa (ECOWAS)	5.62	3.74	0.94	1.06	1.74	1.88	0.59	0.55	0.74
Benin	5.76	4.30	0.95	1.18	2.18	1.46	0.29	0.89	0.28
Burkina Faso	6.39	4.51	1.08	1.25	2.17	1.88	0.57	0.56	0.76
Côte d'Ivoire	4.91	3.26	0.78	0.84	1.65	1.65	0.25	0.58	0.82
Ghana	5.29	3.46	0.87	0.84	1.75	1.83	0.60	0.61	0.62
Guinea	5.10	3.66	1.26	1.04	1.37	1.44	0.06	0.59	0.79
Gambia	5.42	3.39	0.69	1.14	1.56	2.03	0.76	0.54	0.73
Guinea-Bissau	6.05	3.94	1.00	1.21	1.73	2.11	0.76	0.54	0.82
Mauritania	5.57	3.45	0.89	0.93	1.64	2.12	0.79	0.54	0.79
Niger	7.11	5.25	1.35	1.37	2.53	1.87	0.46	0.56	0.85
Nigeria	6.48	3.78	1.01	0.86	1.91	2.71	0.69	1.41	0.61
Senegal	5.23	3.74	0.73	1.09	1.92	1.49	-0.36	0.97	0.89
Sierra Leone	5.93	3.72	1.11	1.06	1.55	2.21	0.85	0.53	0.83
Togo	6.89	4.55	0.93	1.49	2.13	2.34	0.69	1.06	0.59
East Africa (EAC)	6.49	4.37	1.31	1.37	1.69	2.13	0.65	0.70	0.78
Burundi	6.46	4.37	1.24	1.45	1.68	2.09	0.70	0.54	0.85
Kenya	5.88	3.63	0.95	1.00	1.68	2.25	0.76	0.73	0.76
Rwanda	6.72	4.58	1.27	1.58	1.73	2.14	0.77	0.54	0.83
Tanzania	6.01	3.89	1.18	1.13	1.58	2.13	0.38	0.92	0.82
Uganda	6.45	4.58	1.28	1.28	2.02	1.86	0.45	0.69	0.72
Southern Africa (SADC)	4.60	3.06	0.84	0.64	1.58	1.54	0.46	0.47	0.61
Angola	5.46	3.63	1.07	0.94	1.63	1.83	0.71	0.52	0.61
Botswana	3.80	2.37	0.39	0.72	1.26	1.43	0.28	0.60	0.55
Madagascar	5.68	4.08	1.21	1.27	1.60	1.60	0.22	0.58	0.81
Mauritius	2.86	1.98	0.15	0.27	1.56	0.88	0.29	0.64	-0.06
Malawi	6.06	3.99	1.07	1.13	1.79	2.07	0.78	0.54	0.75
South Africa	3.38	1.97	0.35	0.11	1.51	1.41	0.84	0.65	-0.08
Zambia	4.83	3.35	0.99	0.57	1.79	1.48	1.12	-0.54	0.90
Zimbabwe	4.97	2.77	0.71	0.57	1.48	2.20	0.79	0.71	0.70
Central Africa	6.11	4.25	1.31	1.19	1.75	1.86	0.64	0.50	0.72
Central African Republic	6.10	4.33	1.29	1.33	1.71	1.77	0.26	0.59	0.93
Cameroon	5.92	3.52	1.01	0.82	1.69	2.40	0.75	0.85	0.80
Congo, Rep. of	6.26	3.62	1.14	0.99	1.49	2.64	0.27	1.64	0.73
Ethiopia	6.41	4.59	1.09	1.35	2.15	1.81	0.74	0.28	0.79
Gabon	4.77	2.51	0.68	0.40	1.43	2.26	0.83	0.63	0.80
Sudan	6.08	4.23	0.65	1.01	2.57	1.85	0.75	0.54	0.56
Chad	6.64	4.77	1.39	1.59	1.79	1.87	0.40	0.56	0.90
Congo, Dem. Rep. of	5.94	4.28	1.87	0.88	1.52	1.66	0.83	-0.02	0.85
Memo:									
Africa Region	5.51	3.66	0.98	1.00	1.68	1.85	0.58	0.54	0.73

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

Table 16. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 4: Reaching the representative country in Western Europe, using IK2 index of aggregate infrastructure stocks

Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)

(percent)

	Infrastructure	Infrastructure stocks				Infrastructure quality			
Country	**development**	**Total**	**Telecom**	**Electricity**	**Roads**	**Total**	**Telecom**	**Electricity**	**Roads**
North Africa	**2.35**	**1.33**	**0.50**	**0.45**	**0.39**	**1.02**	**0.41**	**0.49**	**0.11**
Algeria	2.80	1.38	0.47	0.48	0.43	1.43	0.83	0.44	0.15
Egypt	1.67	0.93	0.26	0.35	0.31	0.74	0.24	0.26	0.24
Libya	2.09	0.46	0.29	0.08	0.09	1.63	0.43	0.89	0.31
Morocco	2.61	1.69	0.52	0.49	0.67	0.92	0.21	0.30	0.42
Tunisia	2.35	1.33	0.32	0.37	0.64	1.02	0.41	0.22	0.39
West Africa (ECOWAS)	**4.17**	**2.48**	**0.94**	**1.04**	**0.51**	**1.68**	**0.57**	**0.41**	**0.71**
Benin	4.31	3.05	0.95	1.15	0.94	1.26	0.26	0.75	0.25
Burkina Faso	4.93	3.25	1.08	1.23	0.94	1.68	0.54	0.42	0.72
Côte d'Ivoire	3.46	2.01	0.77	0.82	0.41	1.45	0.22	0.44	0.78
Ghana	3.84	2.20	0.87	0.81	0.52	1.64	0.57	0.47	0.59
Guinea	3.64	2.40	1.25	1.01	0.13	1.24	0.03	0.46	0.75
Gambia	3.97	2.14	0.69	1.12	0.33	1.83	0.73	0.41	0.69
Guinea-Bissau	4.60	2.68	1.00	1.19	0.50	1.92	0.73	0.40	0.78
Mauritania	4.12	2.19	0.89	0.90	0.40	1.92	0.76	0.40	0.76
Niger	5.66	3.99	1.35	1.35	1.29	1.67	0.44	0.42	0.81
Nigeria	5.03	2.52	1.01	0.84	0.67	2.51	0.66	1.27	0.58
Senegal	3.78	2.48	0.73	1.07	0.68	1.30	-0.39	0.83	0.85
Sierra Leone	4.48	2.46	1.11	1.04	0.32	2.01	0.83	0.39	0.80
Togo	5.43	3.29	0.93	1.47	0.89	2.14	0.67	0.92	0.55
East Africa (EAC)	**5.04**	**3.11**	**1.31**	**1.35**	**0.46**	**1.93**	**0.62**	**0.56**	**0.74**
Burundi	5.00	3.11	1.24	1.43	0.45	1.89	0.68	0.40	0.81
Kenya	4.43	2.38	0.95	0.98	0.45	2.05	0.74	0.59	0.72
Rwanda	5.26	3.33	1.27	1.56	0.50	1.94	0.75	0.40	0.79
Tanzania	4.56	2.63	1.18	1.11	0.35	1.93	0.36	0.79	0.78
Uganda	4.99	3.33	1.28	1.26	0.79	1.66	0.42	0.56	0.69
Southern Africa (SADC)	**3.14**	**1.80**	**0.84**	**0.62**	**0.35**	**1.34**	**0.44**	**0.33**	**0.57**
Angola	4.01	2.38	1.07	0.92	0.40	1.63	0.68	0.38	0.57
Botswana	2.35	1.12	0.39	0.70	0.03	1.23	0.26	0.46	0.51
Madagascar	4.22	2.82	1.21	1.24	0.37	1.40	0.19	0.44	0.77
Mauritius	1.40	0.72	0.15	0.24	0.33	0.68	0.26	0.50	-0.09
Malawi	4.61	2.73	1.07	1.11	0.55	1.87	0.75	0.40	0.72
South Africa	1.93	0.72	0.35	0.09	0.27	1.21	0.81	0.51	-0.11
Zambia	3.37	2.10	0.99	0.55	0.56	1.28	1.09	-0.68	0.86
Zimbabwe	3.52	1.51	0.71	0.54	0.25	2.01	0.76	0.58	0.66
Central Africa	**4.66**	**3.00**	**1.31**	**1.17**	**0.52**	**1.66**	**0.61**	**0.36**	**0.68**
Central African Republic	4.65	3.08	1.29	1.31	0.48	1.57	0.23	0.45	0.89
Cameroon	4.47	2.26	1.00	0.80	0.46	2.20	0.72	0.71	0.77
Congo, Rep. of	4.80	2.36	1.14	0.96	0.26	2.44	0.24	1.51	0.69
Ethiopia	4.95	3.34	1.09	1.33	0.92	1.62	0.72	0.15	0.75
Gabon	3.32	1.26	0.68	0.38	0.20	2.06	0.80	0.49	0.77
Sudan	4.62	2.97	0.64	0.99	1.34	1.65	0.72	0.41	0.52
Chad	5.19	3.52	1.39	1.57	0.56	1.67	0.38	0.42	0.87
Congo, Dem. Rep. of	4.48	3.02	1.87	0.86	0.29	1.46	0.81	-0.16	0.81
Memo:									
Africa Region	**4.05**	**2.40**	**0.98**	**0.97**	**0.45**	**1.65**	**0.56**	**0.40**	**0.69**

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.

Source: Author's calculations.

Table 17. Potential growth improvement in African countries due to higher infrastructure development (by type of infrastructure asset)

Scenario 5: Reaching the country leader in Western Europe, using IK2 index of aggregate infrastructure stocks
Main telephone lines (per 1,000 workers), electricity-generating capacity (megawatts per 1,000 workers), total roads (km. per sq. km. of arable land)
(percent)

Country	Infrastructure development	Infrastructure stocks: Total	Telecom	Electricity	Roads	Infrastructure quality: Total	Telecom	Electricity	Roads
North Africa	3.04	1.83	0.50	0.71	0.62	1.21	0.44	0.63	0.15
Algeria	3.50	1.88	0.47	0.74	0.67	1.62	0.86	0.57	0.19
Egypt	2.36	1.43	0.26	0.62	0.55	0.93	0.26	0.39	0.28
Libya	2.78	0.96	0.29	0.35	0.32	1.82	0.45	1.02	0.35
Morocco	3.30	2.19	0.53	0.75	0.91	1.11	0.23	0.43	0.45
Tunisia	3.04	1.83	0.32	0.63	0.88	1.21	0.44	0.35	0.42
West Africa (ECOWAS)	4.86	2.99	0.94	1.30	0.74	1.87	0.59	0.54	0.74
Benin	5.00	3.55	0.95	1.42	1.18	1.45	0.29	0.88	0.28
Burkina Faso	5.63	3.75	1.08	1.49	1.17	1.87	0.57	0.55	0.75
Côte d'Ivoire	4.15	2.51	0.78	1.08	0.65	1.64	0.25	0.57	0.82
Ghana	4.53	2.70	0.87	1.08	0.75	1.83	0.60	0.61	0.62
Guinea	4.33	2.90	1.26	1.28	0.37	1.43	0.06	0.59	0.78
Gambia	4.66	2.64	0.69	1.38	0.56	2.02	0.76	0.54	0.73
Guinea-Bissau	5.29	3.19	1.00	1.45	0.73	2.10	0.76	0.53	0.81
Mauritania	4.81	2.70	0.89	1.17	0.64	2.11	0.79	0.53	0.79
Niger	6.35	4.49	1.35	1.61	1.53	1.86	0.46	0.55	0.84
Nigeria	5.72	3.02	1.01	1.10	0.91	2.70	0.68	1.40	0.61
Senegal	4.47	2.99	0.73	1.34	0.92	1.49	-0.37	0.97	0.89
Sierra Leone	5.17	2.97	1.11	1.30	0.56	2.20	0.85	0.52	0.83
Togo	6.13	3.79	0.93	1.73	1.13	2.33	0.69	1.05	0.59
East Africa (EAC)	5.73	3.62	1.31	1.61	0.70	2.12	0.65	0.69	0.77
Burundi	5.70	3.62	1.24	1.69	0.68	2.08	0.70	0.53	0.84
Kenya	5.12	2.88	0.95	1.25	0.69	2.24	0.76	0.72	0.76
Rwanda	5.95	3.83	1.27	1.82	0.74	2.13	0.77	0.53	0.83
Tanzania	5.25	3.14	1.18	1.37	0.58	2.12	0.38	0.92	0.81
Uganda	5.68	3.83	1.28	1.52	1.03	1.85	0.45	0.69	0.72
Southern Africa (SADC)	3.84	2.30	0.84	0.88	0.59	1.53	0.46	0.46	0.61
Angola	4.70	2.88	1.07	1.18	0.63	1.82	0.70	0.51	0.61
Botswana	3.04	1.62	0.39	0.96	0.27	1.42	0.28	0.59	0.55
Madagascar	4.92	3.32	1.21	1.51	0.61	1.59	0.21	0.58	0.80
Mauritius	2.09	1.23	0.15	0.51	0.57	0.87	0.29	0.64	-0.06
Malawi	5.30	3.23	1.07	1.37	0.79	2.06	0.78	0.54	0.75
South Africa	2.62	1.22	0.35	0.35	0.51	1.40	0.84	0.64	-0.08
Zambia	4.07	2.60	0.99	0.81	0.79	1.47	1.12	-0.54	0.90
Zimbabwe	4.21	2.01	0.71	0.81	0.49	2.20	0.79	0.71	0.70
Central Africa	5.35	3.50	1.31	1.43	0.76	1.85	0.64	0.49	0.72
Central African Republic	5.34	3.58	1.29	1.57	0.71	1.76	0.25	0.58	0.92
Cameroon	5.16	2.76	1.01	1.07	0.69	2.39	0.75	0.85	0.80
Congo, Rep. of	5.49	2.86	1.14	1.23	0.49	2.63	0.27	1.64	0.72
Ethiopia	5.64	3.84	1.09	1.59	1.15	1.80	0.74	0.28	0.79
Gabon	4.01	1.76	0.68	0.65	0.43	2.25	0.83	0.62	0.80
Sudan	5.31	3.47	0.65	1.25	1.58	1.84	0.74	0.54	0.56
Chad	5.88	4.02	1.39	1.83	0.80	1.86	0.40	0.55	0.90
Congo, Dem. Rep. of	5.17	3.52	1.87	1.13	0.53	1.65	0.83	-0.03	0.85
Memo:									
Africa Region	4.74	2.90	0.98	1.24	0.68	1.84	0.58	0.53	0.73

We present the potential increase in the growth rate of output per worker among African countries if their 2001–5 levels of infrastructure stock and quality were to reach the 2001–5 levels of infrastructure stock and quality of a specific benchmark country. We also show the decomposition of this potential increase in productivity growth due to the different dimensions of infrastructure stock and quality. Our calculations use the IK1 aggregate index of infrastructure stock and the estimates in column [IK1] of table 2. Note that the leader in infrastructure (both in assets and quality of services) is Mauritius.
Source: Author's calculations.

About AICD

This study is part of the Africa Infrastructure Country Diagnostic (AICD), a project designed to expand the world's knowledge of physical infrastructure in Africa. AICD will provide a baseline against which future improvements in infrastructure services can be measured, making it possible to monitor the results achieved from donor support. It should also provide a more solid empirical foundation for prioritizing investments and designing policy reforms in the infrastructure sectors in Africa.

AICD will produce a series of reports (such as this one) that provide an overview of the status of public expenditure, investment needs, and sector performance in each of the main infrastructure sectors, including energy, information and communication technologies, irrigation, transport, and water and sanitation. The World Bank will publish a summary of AICD's findings in November 2009. The underlying data will be made available to the public through an interactive Web site allowing users to download customized data reports and perform simple simulation exercises.

The first phase of AICD focuses on 24 countries that together account for 85 percent of the gross domestic product, population, and infrastructure aid flows of Sub-Saharan Africa. The countries are: Benin, Burkina Faso, Cape Verde, Cameroon, Chad, Congo (Democratic Republic of Congo), Côte d'Ivoire, Ethiopia, Ghana, Kenya, Madagascar, Malawi, Mali, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, South Africa, Sudan, Tanzania, Uganda, and Zambia. Under a second phase of the project, coverage will be expanded to include additional countries.

AICD is being implemented by the World Bank on behalf of a steering committee that represents the African Union, the New Partnership for Africa's Development (NEPAD), Africa's regional economic communities, the African Development Bank, and major infrastructure donors. AICD grew from an idea presented at the inaugural meeting of the Infrastructure Consortium for Africa, held in London in October 2005.

Financing for AICD is provided by a multi-donor trust fund to which the main contributors are the Department for International Development (United Kingdom), the Public Private Infrastructure Advisory Facility, Agence Française de Développement, and the European Commission. A group of distinguished peer reviewers from policy making and academic circles in Africa and beyond reviews all of the major outputs of the study, with a view to assuring the technical quality of the work.

This and other papers analyzing key infrastructure topics, as well as the underlying data sources described above, will be available for download from www.infrastructureafrica.org. Freestanding summaries are available in English and French.

Inquiries concerning the availability of datasets should be directed to vfoster@worldbank.org.