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Assessing the Impact of Infrastructure Quality on Firm Productivity in Africa*

Cross-Country Comparisons Based on Investment Climate Surveys from 1999 to 2005

by

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Abstract

This paper provides a systematic, empirical assessment of the impact of infrastructure quality on the total factor productivity (TFP) of African manufacturing firms. This measure is understood to include quality in the provision of customs clearance, energy, water, sanitation, transportation, telecommunications, and information and communications technology (ICT). We apply microeconometric techniques to investment climate surveys (ICSs) of 26 African countries carried out in different years during the period 2002–6, making country-specific evaluations of the impact of investment climate (IC) quality on aggregate TFP, average TFP, and allocative efficiency. For each country we evaluated this impact based on 10 different productivity measures. Results are robust once we control for observable fixed effects (red tape, corruption and crime, finance, innovation and labor skills, etc.) obtained from the ICSs. We ranked African countries according to several indices: per

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capita income, ease of doing business, firm perceptions of growth bottlenecks, and the concept of demeaned productivity (Olley and Pakes 1996). We divided countries into two blocks: high-income-growth and low-income-growth. Infrastructure quality has a low impact on TFP in countries of the first block and a high (negative) impact in countries of the second. We found heterogeneity in the individual infrastructure elements affecting countries from both blocks. Poor-quality electricity provision affects mainly poor countries, whereas problems dealing with customs while importing or exporting affects mainly faster-growing countries. Losses from transport interruptions affect mainly slower-growing countries. Water outages affect mainly slower-growing countries. There is also some heterogeneity among countries in the infrastructure determinants of the allocative efficiency of African firms.

Key words: Africa, Infrastructure, Total Factor Productivity, Investment Climate, Competitiveness.

JEL Classification: D21, D24, D61, L60, O55, O57.

1. The wide-ranging effects of infrastructure quality

For Africa's awaited growth resurgence to occur, a broad range of factors—political, institutional, and economic—must be improved. The World Bank's landmark Africa Competitiveness Report (ACR) (2004 and 2007) focuses on problems that, in the words of Artadi and Sala-i-Martin (2003), constitute the most important growth tragedy of the twentieth century—a phenomenon that has received special attention in recent growth literature, such as that of Ndulu and O'Connell (2005). It is agreed that improving Africa's infrastructure is a crucial step toward penetrating international markets and meeting the goals of continuous growth and poverty reduction.

Infrastructure quality has a pervasive influence on all areas of an economy. Low-quality infrastructure and limited transport and trade services increase logistical and transaction costs, rendering otherwise competitive products uncompetitive, as well as limiting rural production and people's access to markets—with adverse effects on economic activity and poverty reduction. A large number of empirical studies illustrate the impact of infrastructure on economic performance, including those of Calderón et al. (2003a and b), Calderón and Serven (2003), Canning (1998), Reinikka and Svensson (1999), Prud'homme (2004), Escribano and Guasch (2005), Escribano et al. (2005), and Guasch (2004). All suggest that Africa's infrastructure gap is an important growth bottleneck with a negative impact on productivity and the overall competitiveness of the region. Furthermore, several studies using the methodology of Escribano and Guasch (2005, 2008) and Escribano et al. (2008a and b and 2009) have found empirical evidence—in cases such as Brazil, Chile, Costa Rica, Mexico, Turkey, and several southeast Asian countries—that improvements in investment climate (IC) conditions in general, and in infrastructure quality in particular, may lead to important gains in productivity and in other economic performance measures: employment, real wages, exporting activities, and foreign direct investment (FDI) inflows.

Disentangling the ways that infrastructure affects Africa's economic growth poses several difficulties because of the special characteristics of the African region. The comprehensive analysis found in Estache (2005) takes stock of the basic characteristics of infrastructure in Sub-Saharan Africa and the impact of 1990 reforms, pointing out that the impact of infrastructure in Africa may be different than in other regions. As Brunel (2004) signals, the colonial period has had a lasting effect on the use of space in the region, resulting in a productive structure that consists, in most cases, of coastal cities connected inland by railways designed to carry raw materials to main ports. This and other factors that are progressively modifying the continent's productive structure—such as continuous urbanization, the movement of economic activity from the agricultural to manufacturing and service sectors, and the increasing openness of African economies—has caused both a quantitative and

qualitative mismatch between the current supply of infrastructure and ever-increasing demand. Factors such as inequality across income levels (affecting the affordability of infrastructure services), large and unoccupied areas, and regional variations in climate are increasingly becoming a concern for African policy makers managing infrastructure.

In addition to furthering the regional integration needed to support infrastructure investment, African governments made important contributions to infrastructure development in the decades following independence. The majority of African state monopolies were, however, characterized by inefficient bureaucracies. These became increasingly unable to satisfy customer demands, with increasing deficits. By the beginning of the 1980s, most African countries embarked on infrastructure sector reforms, with the aim of increasing private sector participation in provision. Despite attempts to introduce more competition and to attract private investors, Africa continues to trail the world in both the quantity and quality of its infrastructure, with bottlenecks particularly in the management of current stock.

Figure 1.1 of the appendix on tables and figures shows the geographical distribution of the countries considered in this study, both in North and Sub-Saharan Africa. The countries studied are divided into five main geographical areas, identified in some cases by the major multilateral organization of each region: (a) the North African region, or Maghreb, includes Morocco, Algeria, and Egypt; (b) the Economic Community of West African States (ECOWAS) includes Mauritania, Mali, Niger, Senegal, Burkina Faso, Benin, Cameroon, and Cape Verde; (c) the Horn of Africa region is composed of two countries, Eritrea and Ethiopia; (d) the East African Community (EAC) includes Tanzania, Kenya, Uganda, and Burundi; and (e) the South African Development Community (SADC), for which we have data for Malawi, Zambia, Namibia, Botswana, Swaziland, Lesotho, and Madagascar. South Africa and Mauritius are the last two individual countries included in the report.

[FIGURE 1.1 ABOUT HERE]

The 26 countries show enormous heterogeneity due to (a) geographical factors, such as whether a nation is landlocked (Cape Verde, Madagascar, and Mauritius), tropical (with landmass for the most part covered by rainforests), or dominated by deserts (such as the North African countries Mauritania and Namibia); (b) social or political factors, such as civil wars, armed conflicts, early democracies, dictatorships, and colonial heritage; and (c) economic factors, which this paper discusses for all countries, from the most affluent (Mauritius) to the poorest (Eritrea).

Figure 1.2 clarifies the different evolutions of per capita income across the countries included in this analysis. Out of the 26 African countries analyzed, Mauritius was, in 1950, the

country with the highest per capita income (measured in terms of per capita gross domestic product, GDP), followed closely by South Africa, and, by a wider gap, Namibia and Algeria. But the per capita income situation in 2003 was somewhat different; Mauritius was still ranked first, followed by Swaziland, South Africa, and Botswana—and, by a wider gap, Algeria, Cape Verde, Egypt, and Morocco. Panel B of figure 1.2 shows the five-year growth rate of per capita income. Mauritius and Botswana are the countries that have experienced the highest, sustained per capita income growth during the recent years. Lesotho is the median country, splitting the cross-section into two blocks. The first block comprises countries with faster and steadier growth rates (Mauritius, Swaziland, South Africa, Botswana, Namibia, and Lesotho in the south; Algeria, Morocco, and Egypt in the north; and Cape Verde and Cameroon in central Africa). In the second are countries with lower and more irregular growth rates (Mauritania, Senegal, Benin, Mali, Niger, and Burkina Faso in the central west; Uganda, Kenya, Zambia, Tanzania, Malawi, Burundi, Madagascar, Ethiopia, and Eritrea from the central east), periods of positive expansion fluctuate with those of persistent reductions in per capita income.

[FIGURE 1.2 ABOUT HERE]

These per capita income rankings are correlated with the rankings obtained from the World Bank's 2007 Doing Business Report (DBR), presented in panel C of figure 1.2. In 2007 Mauritius, Swaziland, South Africa, Botswana, and Namibia rank 32nd, 76th, 29th, 48th, and 42nd in the world based on the ease-of-doing-business indicators. This index considers questions such as the number of days required to start a business and the ease of dealing with licenses, registering a property, trading across borders, employing workers, and so on. Other 2007 rankings include 83rd for Kenya, 97th for Ethiopia, 165th for Egypt, and 170th for Eritrea.

To better understand the convergence or divergence of trends, we plotted the per capita income of each African country relative to the per capita income of the United States (see panel A of Figure 1.3). Convergence is observed only in Mauritius, Swaziland, and Botswana. For all other study countries, including South Africa, per capita income is diverging from the United States, while in a few (Egypt, Morocco, and Cape Verde) the ratio has remained stable. While persistently positive GDP growth allowed Mauritius's per capita income to reach 45 percent of the United States in 2003, this is clearly the exception (together with Swaziland and Botswana). For the rest of the countries, including South Africa, relative per capita income was much lower in 2003 than in 1960 (indicating divergence). In fact, the 2003 per capita income of several countries was no larger than 5 percent of the per capita income of the United States. As expected, labor productivity is the main factor explaining this divergence in per capita income in Africa (panel B of Figure 1.3), given that labor force participation has a steady

influence (panel C of Figure 1.3).[1] Since TFP is usually a key factor explaining the evolution of labor productivity, in this paper we seek to use investment climate surveys (ICSs) to identify the main infrastructure-related TFP bottlenecks in Africa.

[FIGURE 1.3 ABOUT HERE]

Figure 1.4 shows the percentage of firms that *perceive* telecommunications, electricity, customs clearance, and transport as major obstacles to their economic performance. Only in Benin, Kenya, and Zambia do more than 50 percent of firms identify telecommunications as a severe obstacle. The quality of electricity provision is a major problem for more than 50 percent of firms in more than half of the countries in our sample. In Burundi, Cameroon, Benin, Burkina Faso, and Cape Verde, the percentage of firms considering electricity as a severe or very severe obstacle exceeds 80 percent; on the other hand, only 20 percent of firms in Morocco, South Africa, Botswana, and Namibia consider electricity a severe obstacle. Customs clearance is considered an acute problem in Benin, Kenya, Madagascar, Senegal, and Algeria. Finally, transportation is considered a severe obstacle by more than 70 percent of firms in Burkina Faso and Benin.

[FIGURE 1.4 ABOUT HERE]

Figure 1.5 offers another view of the state of infrastructure in Africa. The World Bank's ACR (2007) evaluates a wide range of factors related to economic activity, infrastructure among them. Once again there are clearly different performance levels across the two blocks of countries. While in Namibia, South Africa, Botswana, Egypt, and Morocco the quality of infrastructure exceeds the approval level; in the remaining countries this quality is rated low in most cases. The same holds for the disaggregated results, including the number of telephone lines and the quality of ports, air transport, and electricity supply.

[FIGURE 1.5 ABOUT HERE]

The difference between the two blocks becomes even clearer in figure 1.6, where the cross-plots between GDP per capita relative to the United States and firms' perceptions are presented. A preliminary analysis of the cross-plots suggests two points: first, that there is an

[1] The *per capita income* of country J (Y^J/P^J) is decomposed into labor productivity (Y^J/L^J) and the employment-population rate (L^J/P^J) by following the expression: $(Y^J/P^J) = (Y^J/L^J)*(L^J/P^J)$, where Y is GDP, L is total labor force, and P is total population.

intuitive and negative relation between income level and infrastructure constraints; and, second, that the diversion of the two blocks of countries remains intact, showing now the largest dispersion in the constraint perceptions of figure 1.6 for the lowest per capita income group.

[FIGURE 1.6 ABOUT HERE]

The objective of this paper is to assess the impact of the quality of existing infrastructure on the TFP of African firms. This measure is understood to include quality in the provision of the following services: customs clearance, energy, water, sanitation, transportation, telecommunications, and information and communications technology (ICT). We also want to identify infrastructure factors with statistically significant impacts on TFP, country by country. In the econometric evaluation we use 10 different measures of TFP and show that the results are robust—no matter what measure of TFP is used—if we follow the econometric methodology of Escribano and Guasch (2005, 2008), and Escribano et al. (2008).

For the empirical analysis of infrastructure's constraints on TFP, we go down to the firm level since infrastructure is one of the key elements of a country-specific IC, and a significant component of country competitiveness. To provide reliable and robust estimates of the impact of infrastructure on economic performance is not a straightforward task. As we will see later on, we have to deal with the heterogeneity of the countries included in our sample, and the endogeneity of explanatory variables (inputs and IC variables) in several dimensions due to unobservable fixed effects, measurement errors, missing observations, and so on. To solve these problems, we take advantage of the useful and rich firm-level information provided by the ICSs undertaken by the World Bank in Africa from 2002 to 2006. These surveys capture firm-level information in a range of areas related to economic performance: infrastructure, financing, governance, corruption, crime, regulation, tax policy, labor relations, conflict resolution, supplies and marketing, quality, technology, and training, among others. These surveys offer information on the production function (PF) variables over one, two, or three years, depending on the African country. But for infrastructure and other IC and plant control (C) variables they only provide information for a single year. We will see how we can use this valuable information to evaluate how firms operate in Africa and to identify the main obstacles to productivity improvements.

Section 2 of this report clarifies the link between this type of empirical work and existing literature on infrastructure and productivity. The properties and quality of the ICSs are analyzed in section 3. Why we classify the IC factors in broad categories or groups will also be discussed, together with the infrastructure variables (INFs) used. In section 4 we present the econometric

methodology we use to estimate the impact of infrastructure and other IC variables and C characteristics on TFP. Once we have estimated the infrastructure and other IC elasticities and semi-elasticities on productivity, we evaluate the effects of infrastructure on aggregate productivity and on allocative efficiency, using the Olley and Pakes (O&P, 1996) decomposition. The main empirical results are described in the remaining sections. In particular, section 5 focuses on the relative importance of infrastructure in the IC of each country. Section 6 presents the empirical results country by country, and section 7 includes the main conclusions. Most of the tables and figures are included in the appendix at the end of the paper.

2. How does infrastructure quality affect economic performance?

Much literature discusses the different ways that infrastructure affects growth and other development outcomes at the macroeconomic level. For example, the World Bank's landmark World Development Report (1994) highlighted multiple links between infrastructure and development and emphasized how policy can improve not only the quantity, but also the quality, of infrastructure services in developing countries.

As Straub (2008) signals, macrolevel literature has too often sought to obtain the elasticity of infrastructure capital and compare it with the elasticity of private capital. Few papers go beyond measures of infrastructure spending and infrastructure stocks to consider the issue of infrastructure efficiency. Since the seminal paper of Aschauer (1989) found that infrastructure capital has a large impact on aggregate TFP, this finding has been replicated by a number of earlier studies: Munnell (1990a, 1990b, 1992) for the United States, Mitra et al. (2002) for that of India, and Easterly and Rebelo (1993) for cross-sectional country data. Loayza, Fajnzylber, and Calderón (2002) find that a telecommunications indicator is robustly related to growth in a large panel data set that includes both industrial and developing countries.

For the case of Africa, studies exploring the relation between infrastructure and growth are scarce.[2] Traditionally, infrastructure services have been viewed as public goods in Africa, with their provision entrusted to government monopolies. The overall performance of government-owned providers of infrastructure in Africa has been very poor. This sector is characterized by high inefficiency, a lack of technological dynamism, and very poor service provision. In addition, the provision of infrastructure-related services in most African countries is characterized by high prices and long waits between the time of application for services and

[2] Estache (2005) points out the two main reasons for ignoring the role of infrastructure as one of the most important drivers of economic growth in Africa: (a) econometric focus on human capital, and (b) low quality of available data.

actual connection. Many African economies are also endowed with adverse natural and geographical attributes, such as lack of access to sea ports and tropical climates.

The Economic Commission for Africa (ECA) Report (2005) and Sachs et al. (2004) have explored the African need for new investments in infrastructure, but without a properly systematic cross-country analysis. Estache et al. (2005) makes one of the first attempts to conduct a more systematic, quantitative assessment of the importance of Sub-Saharan Africa's infrastructure. The main finding of this paper is that electricity, water, roads, and telecommunications are crucial factors in promoting growth, with colonial and postcolonial histories also being important factors explaining some of the differences among countries. On the other hand, Esfahani and Ramirez (2003) estimate that Sub-Saharan Africa's poor growth performance is, in part, related to underinvestments in electricity and telecommunications infrastructure. Estache (2005) estimates that if Africa had enjoyed Korea's quantity and quality of infrastructure, it would have raised its annual growth per capita by about 1 percent. Hulten (1996) finds that differences in the effective use of infrastructure resources explain one-quarter of the growth differential between Africa and East Asia, and more than 40 percent of the growth differential between low- and high-growth countries.

Empirical explorations of infrastructure's effect on growth and productivity, however, have been characterized by ambiguous results with little robustness. The possible endogeneity of infrastructure measures has been advanced as a reason for contradictory findings of the impact of public capital on long-run economic development indicators. Literature has signaled that endogeneity in this context might come from three sources: (a) measurement errors stemming from the use of public capital figures as proxies for infrastructure; (b) omitted variables, which may arise when there is a third variable, unobserved, that affects the infrastructure and growth measure; and (c) the fact that under the simultaneous determination of infrastructure and productivity or output, the bias and inconsistency of standard estimators would follow where infrastructure provision itself positively responds to productivity gains.[3] Possible reasons for such feedback would arise with increased reliance on the private sector for the provision of infrastructure services, or with successful lobbying by industry interest groups that experience either positive productivity gains or constraints on performance due to infrastructure provision.

Various panel data and country studies have tried to address these issues. Röller and Waverman (2001) explicitly model and estimate the impact of telecommunications under simultaneity. In a cross-country panel estimation, Calderón and Serven (2003, 2005) employ

[3] Notice that we avoid using the terms *causality* or *reverse causality*, since there is no control group to compare against and the temporal dimension is not large enough to consider Granger-causality concepts. Therefore, we use the terms *simultaneity* and *identification*, which are more appropriate for ICSs.

generalized method of moments (GMM) panel estimation methods to control for the possibility of endogeneity, reporting significant improvements in results. Dessus and Herrera (1999) allow for simultaneity in a panel data set for 28 countries. Country-specific time series also confirm the presence of simultaneity between output and infrastructure measures—see Frutos et al. (1998) for Spain, and Fedderke et al. (2005) for South Africa. Also for South Africa, Fedderke and Bogetic (2006)—controlling for the potential endogeneity of infrastructure in estimation—robustly eliminate nearly all evidence of possible overinvestment in infrastructure. Indeed, controlling for the possible endogeneity of infrastructure measures renders the impact of infrastructure capital positive. Romp and Haan (2005) indicate that when simultaneity is taken into consideration, the elasticity estimates found in earlier studies considerably decrease.

Another possibility behind the ambiguous results obtained from empirical studies of public capital impacts on output might simply be that aggregate measures of infrastructure hide the productivity impact of infrastructure at a more disaggregated level. A second batch of studies, focusing mainly on microdata, reveals the existence of the possible indirect impact of infrastructure on economic growth and economic performance beyond the effect of the simple accumulation of capital. Thus, for instance, Shioji (2001) finds that the positive impact of infrastructure arises in panel data on U.S. and Japanese industries once public capital is properly disaggregated. Agénor and Moreno-Dodson (2006) point out that improvement in the stock of infrastructure can reduce the adjustment costs of private capital by (a) lowering the logistical cost of the investment in private capital, and (b) allowing the replacement of unproductive private investments such as electricity generators or boreholes and wells with more productive investments in machinery and equipment. This assumption has been tested in the context of investment climate assessments (ICAs) with firm-level information. Reinikka and Svensson (1999) show that improvements in the infrastructure stock in Uganda make infrastructure services more reliable, reducing the necessity of investing in less productive substitutes (such as generators) in order to avoid potential service interruptions, and thus freeing funding of private productive investments.

Relationships at a more disaggregated level tend to be obscured by aggregated data, and are unobservable with country-level data. Another channel of infrastructure impact is via improvements in labor productivity through (a) improved transport between home and work, and (b) more efficient work processes. Another way that better infrastructure might increase labor productivity is through improvements in health and education, making existing human capital more efficient, and promoting successive investments in human capital (Galiani et al., 2005).

The effect of infrastructure on firms' international integration has also been tested. Recent literature affirms that improvements in transportation services and infrastructure can

lead to improvements in export performance. Thus, for instance, Francois and Manchin (2006) explore the role that infrastructure plays (among other factors such as policy reforms, institutional development, colonial history, development assistance, and general north-south differences) in the different trade performances observed in the so-called *globalizer* countries such as India and China, as well as other developing countries (many located in Africa and with a very different story to tell regarding the integration of the global economy). Limão and Venables (2001) show that infrastructure is quantitatively important in determining transport costs, concluding that poor infrastructure accounts for much of the different transport costs observed in coastal and landlocked countries. Bougheas et al. (1999), in the context of gravity models, find evidence in the European economy of a positive relationship between the level of infrastructure and the volume of trade. Wilson et al. (2004) consider ports, customs, regulations, and e-businesses as proxies of trade-facilitation efforts, finding that the scope and benefit of unilateral trade-facilitation reforms are very large, and that the gains fall disproportionately to exports.

In a world where governments compete to attract more FDI inflows through a variety of investment and tax incentives and other policy preferences, the availability of good-quality physical infrastructure could also increase the inflow of FDI by subsidizing the cost of total investment by foreign investors and thus raising the rate of return. The favorable role of physical infrastructure in influencing patterns of FDI inflows has been corroborated by recent studies, such as those of Loree and Guisinger (1995), Mody and Srinivasan (1996), and Kumar (2001), among others. Multinational enterprises may consider the quality of available infrastructure especially important while deciding to relocate export-platform production undertaken for efficiency considerations. In other words, the quality of physical infrastructure could be an important consideration for multinationals in their location choices, for FDI in general, and for efficiency-seeking production in particular.

As has been pointed out, the main concern of this paper is to offer a robust assessment of the various channels through which infrastructure quality may impact TFP. Thus, instead of the quantity of macrovariables, we use, as an explanatory variable, the quality of existing infrastructure stock. Instead of aggregate infrastructure measures usually included in macromodels, such as kilometers of paved roads or total number of telephone lines, we incorporate measures that allow us to identify direct relationships between infrastructure and economic performance at a more disaggregated level. Additionally, by going down to the firm level, we avoid the endogeneity problems of the macrolevel variables. Nevertheless, microlevel data have specific endogeneity problems, and several variables cannot be considered to be exogenously determined; for instance, public investment decisions are likely to be affected by expected returns on investment, and firms faced with different quality and availability of

infrastructure services would choose different technologies. The solutions proposed in this methodology allow us to obtain a robust assessment of the impact of infrastructure quality on TFP.

3. Country-level data and their treatment in the study

Produced by the World Bank, ICSs of private enterprises explore the difficulties that firms located in developing countries encounter in starting and running businesses. More precisely, the surveys capture firms' experiences in a range of areas related to economic performance: financing, governance, corruption, crime, regulation, tax policy, labor relations, conflict resolution, infrastructure, supplies and marketing, quality, technology, training, and so on. For that purpose, we classify IC factors in five categories to evaluate the impact of each group on economic performance. In the first group—infrastructure—we include all related variables such as customs clearance, power and water supply, telecommunications (including phone connection and information technology, IT), and transportation. In the second group—red tape, corruption, and crime—we include IC factors relating to tax rates, conflict resolution, crime, bureaucracy, informalities, corruption, and regulations. The next group comprises financial and corporate governance and includes factors related to management, investments, informalities in sales and purchases, access to finance, and accountability (or auditing). The last group of IC variables includes quality, innovation, and labor skills, as well as quality certifications, technology usage, product and process innovation, research and development (R&D), quality of labor, training, and managers' experience and education. The last group—other C variables—are not properly a group of IC factors, but a group of other firms' control characteristics. We classify in this group all the factors that may have an important impact on economic performance but are not considered IC factors: exports and imports, age, FDI, number of competitors, firm size, and so on. Table A.2 (see appendix 2) includes the whole list of IC and C variables, as well as a description of how each is measured. Likewise, not all surveys provide the same information on ICSs, although there is a common group of variables in each group that is available for all the countries; although the regressions among them are slightly heterogeneous, we can use this common group as a benchmark for comparison purposes.

The ICSs provide information on TPF variables, output (sales), employment, intermediate materials, capital stock, and labor costs. Table A.1 (see appendix) includes information on these variables and indications of how they were measured. The ICSs do not provide information on prices at the firm level, so the production function (PF) variables were deflated by using the World Bank's country-specific consumer price index (CPI), base 2000. The information on the net book value of the capital stock (NBVC) is not available for Algeria, Kenya, Mali, Senegal, and Uganda; in these cases the NBVC is substituted by the replacement cost of

machinery and equipment, which, in the surveys, is only available for a single year. We thus recursively estimate the missing values of the NBVC from the information on the replacement cost of and the net investment in machinery and equipment by using the permanent inventory method, according to which the capital stock at moment *t* is given by $K_{it}=K_{it-1}(1-\delta)+ I_{it}$. By inverting this formula we can obtain the value of the capital at moment *t-1* as $K_{it-1}=(K_{it} - I_{it})/(1-\delta)$ where K_{it} is approximated with the replacement cost of machinery and equipment, I_{it} is the net investment in machinery and equipment, and δ is the depreciation rate of the machinery and equipment.[4]

In this paper we focus on the manufacturing sector, and while classifying the establishments by their international standard of industrial classification (ISIC) code, we end up with establishments from the next eight sectors: (a) food and beverages; (b) textiles and apparels; (c) chemicals, rubber, and plastics; (d) paper, printing, and publishing; (e) machinery and equipment/metallic products; (f) wood and furniture; (g) nonmetallic products; and (h) other manufacturing.

Classification of countries by geographical area

For the classification of countries by groups used in the regression analysis, we take into account the following facts: (a) the surveys provide different information on PF variables and on IC and C variables; (b) the surveys were carried out in different years during the period 2002–6; (c) the quality of the data varies across surveys; and (d) not all the surveys provide panel data information (recall data) for the PF variables. Thus, we end up with two types of country databases. For those countries with a large enough number of observations available for regression analysis (see column 6 of table 3.1) and with panel data information for the PF variables (for more than one year), we carry out the analysis country by country. For the countries in which surveys were collected in 2006 (which only offer one year of information for PF variables) and the number of firms surveyed was lower than in the previous surveys, we follow the estimation strategy of pooling the information according to the similarity of geographical and economic factors—thus gaining efficiency in the parametrical estimation of the IC parameters (with more observations in the regressions) at the cost of having common IC parameters for some countries.

We end up with two pools of 2006 countries: (a) ECOWAS countries, such as Mauritania, Cameroon, Niger, and Burkina Faso; and (b) SADC countries, such as Botswana, Namibia, and

[4] The depreciation rate used is 15 percent, a standard percentage commonly applied in other works. Other percentages were also used in order to check robustness. Alternatively, to check whether the results were robust for other ways of constructing the NBVC, we used the next formula $K_{it-1}=K_{it}(1-\Delta I_{it})$, where K_{it} is approximated by the replacement cost and $\Delta I_{it=}(I_{it}-I_{it-1})/I_{it-1}$ is the rate of growth of the net investment in machinery and equipment. In both cases the main results were maintained.

Swaziland. Finally, since Eritrea has only 179 observations available, we consider this country as a special region of Ethiopia and carry out a joint analysis of the two, constituting the third pool of countries considered in the analysis.

Table A.3 offers an initial overview of the data we use in the analysis. We have data for 26 countries from five different geographical regions. Cape Verde, Lesotho, and Burundi are special cases. The PF information for Lesotho is rather poor and it is impossible to make reliable statistical inferences with only 79 observations. We did not group Lesotho with the pool of SADC countries because the survey of this country is from 2003 and the information on the IC and C variables is quite different. Burundi presents similar problems—the information on the PF for this country is for a single year (2005), and the number of observations is only 101. Although Burundi belongs to the EAC—along with Kenya, Uganda, and Tanzania—we did not pool Burundi with any of these countries because the information on the PF and the IC comes from different years and with different information on the IC and C variables. Cape Verde is another country with information for a single year (2006) and with only 47 observations available for regression analysis. Because of its obvious difference from the rest of the ECOWAS countries—different per capita income and its condition as an insular state, as well as other geographical considerations—we did not include Cape Verde in this pool. As a result, no regression analyses were conducted for Cape Verde, Lesotho, and Burundi.

[TABLE A.3 ABOUT HERE]

By running the regressions country by country we can use as many infrastructure and other IC and C variables as are available. This allows us to gain heterogeneity estimating the impact of infrastructure on productivity. In addition, we can use more variables as proxies for firm-level, unobservable fixed effects, and we do not have to constrain ourselves to the subset of IC variables common to all the countries.

Cleaning the data

The IC databases are, in some respects, troublesome. From table B.1 (see appendix) it is clear that out of the total number of establishments surveyed there are a considerable number of observations with at least one PF variable missing, and/or with outlier observations in the PF variables.[5] This problem becomes more acute for some countries—such as Algeria, Senegal,

[5] By *outlier*s we mean those observations with ratios of materials to sales and/or labor cost to sales greater than 1.

Eritrea, Tanzania, and Mauritius—where more than half the observations are missing for the regression analysis (see the upper panel of table B.1), which results in the sample representativity being lost. To reduce the effects of this sample selection bias, we apply a preliminary data-cleaning process that allows us to retrieve a considerable number of establishments for the analysis; it is based on a robust simple version of the EM-algorithm of Dempster et al. (1977) (for more details see Little and Rubin, 1987; Escribano et al., 2008). First, we exclude those plants with missing values in all the PF variables—sales, materials, capital stock, and labor cost. We convert outlier observations of PF variables into missing observations, then proceed as follows: (a) we replace the missing values by the corresponding (cells) industry-region-size median of the variables keeping from 15 to 20 observations in each cell; (b) if we do not have enough observations in some cells we replace them with the corresponding industry-size medians; (c) if we still do not have enough observations in those cells we replace them with the region-size medians; and (d) if still necessary, in the last step we compute the medians only by size and/or by industry to replace those missing values. Table B.1 shows that the number of available observations in all the countries considerably increases with the application of this data-cleaning process. Tables B.2.1 and B.2.2 (see appendix 2) show the distribution of the observations (by country and year, and by country and industry, respectively) before and after the cleaning process. From these tables it is clear that this process does not alter much of the original representativity of the ICSs.

The importance of infrastructure among IC variables

As has been previously pointed out, we classify the IC factors in several categories to evaluate the impact of each group on economic performance. The infrastructure group of variables (INFs) is intended to be part of the country-specific IC. Within the infrastructure group we consider the next list of IC variables: customs clearance, energy, water, telecommunications, ICT, and transportation. Table B.4 describes the main INFs used in the empirical analysis.

[TABLE B.4 ABOUT HERE]

The variables listed in table B.4 are common to almost all the countries considered, and are therefore intended to be a benchmark for comparison purposes; however, there are other country-specific variables not listed. For a description of the complete set of variables, along with the countries for which they are available and the response rate of the variables, see table B.3 of the appendix.

Within each infrastructure subgroup we consider different factors. Thus, in the *customs clearance group* the factor considered is the time required to clear customs for exports and

imports, and the time to get an import license. In the *energy group* we consider variables that describe the quality of power provision (number and average duration of power outages, and subsequent losses), the use of a generator as a substitute for the public provision of power, the price of energy either from the public grid or from private generators, and the average time waiting to be hooked up for electricity supply. Similarly, for the *group of water* we consider provision quality, price, the use of alternative supplies of water (such as private wells or boreholes), and the time to get water supply. In the *telecommunications and ICT group*, the variable considered is the quality of the phone provision and the time to obtain a phone connection, as well as the use of ICT technologies (such as Internet or e-mail) in communications with clients and suppliers. The *transport group* mainly incorporates a description of the quality of transportation services and dummy variables for the use of own-transport services (roads, transportation for workers, and so on).

From the econometric point of view we use three types of variables: (a) variables in logs, whose coefficients are interpreted as elasticities; (b) variables in percentages, whose coefficients can be interpreted as semi-elasticities; and (c) dummy variables, for which coefficients from the regressions are interpreted as semi-elasticities.

Finally, some of the variables in the same group are likely to be correlated since they provide similar information; for instance, the number and average duration of power outages and subsequent losses. In order to avoid multicolinariety problems we do not simultaneously use all variables in the regressions, but in the final model specification we test for possibly omitted variables.

4. Evaluating the impact of infrastructure on total factor productivity (TFP)

Escribano and Guasch (2005, 2008) relate infrastructure and other IC and C variables with firm-level productivity (TFP) according to the following observable fixed-effects system of equations:

$$\log Y_{it} = \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \log TFP_{it} \quad (4.1a)$$

$$\log TFP_{j,it} = a_i + \alpha'_D D_i + \alpha_P + w_{it} \quad (4.1b)$$

$$a_i = \alpha'_{INF} INF_i + \alpha'_{IC} IC_i + \varepsilon_i \quad (4.1c)$$

where, Y is firms' output (sales), L is employment, M denotes intermediate materials, K is the capital stock, INF is a time-fixed vector of observable infrastructure variables, IC is a time-fixed effect vector of other investment climate and other control variables, and D is a vector of industry and year dummies.

The usually unobserved time fixed effects (a_i) of the TFP equation (4.1b) is here proxy by the set of observed time-fixed components **INF** and **IC** variables of (4.1c) and a remaining unobserved random effect (ε_i). The two random error terms of the system, ε_i and w_{it}, are assumed to be conditionally uncorrelated with the explanatory L, M, K, **INF** and **IC** variables[6] of equation (4.2):

$$\log Y_{it} = \alpha_L \log L_{it} + \alpha_M \log M_{it} + \alpha_K \log K_{it} + \alpha'_{INF} INF_i + \alpha'_{IC} IC_i + \alpha'_D D_i + \alpha_P + u_{it}. \qquad (4.2)$$

Therefore, the regression equation (4.2) is representing the *conditional expectation* plus a composite RE error term equal to $u_{it} = \varepsilon_i + w_{it}$.

Providing reliable and robust estimates of the impact of infrastructure on productivity is not a straightforward task. First, because the functional form of the PF is not observed and there is no available single salient TFP measure. Second, there is an identification issue separating TFP from PF. When any PF inputs are influenced by unobserved common causes affecting productivity—such as a firm's fixed effects—there is a simultaneous equation problem in equation (4.1a). Third, we could expect that several IC variables have at least some degree of endogeneity, questioning therefore the conditional lack of correlation of (4.2). In what follows of this section, we briefly review the solutions to these questions suggested in Escribano and Guasch (2005, 2008) and Escribano et al. (2008).

Estimating infrastructure's impact on productivity

TFP or multifactor productivity refers to the effects of any variable different from the inputs—labor (L), intermediate materials (M), and capital (K)—affecting the production (Y) process. Since there is no single salient measure of productivity (or *logTFP*$_i$), any empirical evaluation of the productivity impact of INFs might critically depend on the particular productivity measure used. Escribano and Guasch (2005, 2008) suggested—following the literature on *sensitivity analysis* of Magnus and Vasnew (2006)—to look for empirical results (elasticities) that are robust across several productivity measures. This is also the approach we follow in this paper.

In particular, we want the elasticities of INFs on productivity (TFP) to be robust (with equal signs and similar magnitudes) for the 10 different productivity measures used. Alternative productivity measures come from considering:

- Different functional forms of the PFs (Cobb-Douglas and Translog)

[6] Under this formulation (and other standard conditions) the OLS estimator of the productivity equation (4.2) with robust standard errors is consistent, although a more efficient estimator (GLS) is given by the random effects (RE) estimator that takes into consideration the particular covariance structure of the error term, $\varepsilon_i + w_{it}$, which introduces a certain type of heteroskedasticity in the regression errors of (4.2).

- Different sets of assumptions (technology and market conditions) to get consistent estimators based on Solow's residuals, ordinary least squares (OLS), or random effects (RE), and so on
- Different levels of aggregation in measuring input-output elasticities (at the industry level or at the aggregate country level)

Box 4.1 Summary of productivity measures and estimated investment climate (IC) elasticities

1. Solow´s Residual	Two-step estimation	1.1 Restricted coefficient 1.2 Unrestricted coefficient	1.1.a OLS 1.1.b RE 1.2.a OLS 1.2.b RE	2 (P_{it}) measures 4 (IC) elasticities
2. Cobb-Douglas	Single-step estimation	2.1 Restricted coefficient 2.2 Unrestricted coefficient	2.1.a OLS 2.1.b RE 2.2.a OLS 2.2.b RE	4 (P_{it}) measures 4 (IC) elasticities
3. Translog	Single-step estimation	3.1 Restricted coefficient 3.2 Unrestricted coefficient	3.1.a OLS 3.1.b RE 3.2.a OLS 3.2.b RE	4 (P_{it}) measures 4 (IC) elasticities
Total				10 (P_{it}) measures 12 (IC) elasticities

Source: Author's estimations.
Note: Restricted coefficient = equal input-output elasticities in all industries.
Unrestricted coefficient = different input-output elasticities by industry.

Box 4.1 summarizes the productivity measures used for the IC evaluation. The two-step estimation starts from the nonparametric approach based on cost shares from Hall (1990) to obtain Solow's residuals in logs under two different assumptions:[7] (a) the cost shares are constant for all plants located in the same country (restricted Solow residual), and (b) the cost shares vary among industries in the same country (unrestricted by industry Solow residual). Once we have estimated the Solow residuals ($logTFP_i$) in the first step, in the second step we can estimate equation (4.3) by OLS with robust standard errors for the countries that have a single year of data (2006) on PF variables. For the remaining 14 countries and for the blocks of countries described in section 3, we can also estimate (4.3) by RE to obtain the corresponding IC elasticities and semi-elasticities,

$$\log TFP_{it} = \alpha'_{INF} INF_i + \alpha'_{IC} \mathrm{IC}_i + \alpha'_D D_i + \alpha_P + \varepsilon_i + w_{it} \qquad (4.3a)$$

where *INF* is the observable fixed effects vector of infrastructure variables, and *IC* is the observable fixed effects vector of other IC and control variables listed in table A.2 of the appendix. In all the panel data regressions, we always control for several sector-industry

[7] The advantage of the Solow residuals is that they require neither the inputs (L, M, K) to be exogenous nor the input-output elasticities to be constant or homogeneous (Escribano and Guasch, 2005 and 2008). The drawback is that they require having constant returns to scale (CRS) and, at least, competitive input markets.

dummies (D_j, j = 1, 2, . . ., q_D), and in the cases having more than one year of observations we also include a set of time (D_t, t = 1, 2, . . ., q_T) dummy variables and always a constant term (α_P).

For cross-country comparisons based on TFP we use the concept of demeaned TFP,[8] which gets rid of the constant term as well as the constant effects by industry and by year, concentrating therefore on the part of TFP that is influenced by INF, IC, and the other plant-level control variables,

$$Demeaned \log TFP_{it} = \alpha'_{INF} INF_i + \alpha'_{IC} IC_i . \quad (4.3b)$$

In the single-step estimation approach, we consider the parametric estimation by OLS and RE of the extended PF (4.2). To address the well-known problem of the endogeneity of inputs, we follow the approach proposed by Escribano and Guasch (2005, 2008). That is, we proxy the usually unobserved firm-specific fixed effects (which are the main cause of inputs' endogeneity) by a long list of observed firm-specific fixed effects coming from the ICSs. Controlling for the largest set of IC variables and plant characteristics, we can get—under standard regularity conditions—consistent and unbiased least squares estimators of the parameters of the PF and the INF and IC elasticities. Furthermore, we use two different functional forms of the PF—Cobb-Douglas and Translog—under two different assumptions on the input-output elasticities: equal input-output elasticities in all industries (restricted case) and different input-output elasticities by industries (unrestricted case).

Notice that even if we are only interested in assessing the impact of infrastructure on TFP, we do not limit the scope of the control analysis to only this subset of IC variables. We include (and therefore control for) all the IC factors because of the crucial role IC variables play as proxies for the unobserved fixed effects; this is the key feature of this methodology in order to provide robust empirical results. If we tried to estimate only the impact of infrastructure, without controlling for the other blocks of IC variables, we might get different signs on certain coefficients because of the omitted variables problem (Escribano and Guasch, 2008).

Another econometric problem we have to face when estimating the parameters of the INF and IC variables—either from the two-step or single-step procedure—is the possible endogeneity of some of these variables. That is, many INF or IC variables are likely to be determined simultaneously along with any TFP measure. With these productivity equations, the traditional instrumental variable (IV) approach is difficult to implement, given that we only have information for one year, and therefore we cannot use the natural instruments for inputs, such as those provided by their own lags. As an alternative correction for the endogeneity of the INF

[8] Notice that the demeaned TFP concept of equation (4.3b) corresponds to the observable part of the fixed effects equation (4.1c).

and IC variables, we use the region-industry-size average of firm-plant-level INF and IC variables instead of the crude variables,[9] which is a common solution in panel data studies at the firm level[10] (see Veeramani and Goldar, 2004, for other use of industry-region averages with IC variables).

Using industry-region-size averages also mitigates the effect of having certain missing individual INF and IC observations at the plant level, which—as mentioned in section 3—represent one of the most important difficulties of using ICSs. As an alternative, we also follow a second strategy to deal with the missing values of some INF and IC variables. In order to keep as many observations in the regressions as possible to avoid losing efficiency, when the response rate of the variables is large enough, we decided to replace those missing observations with the corresponding industry-region-size average.[11] Thus, we gain observations, efficiency, and representativity at the cost of introducing measurement errors into some variables.[12]

The econometric methodology applied for the selection of the variables (INF and IC) goes from the general to the specific. The otherwise omitted variables that we encounter—starting from a too-simple model—generate biased and inconsistent parameter estimates. We start the selection of variables with a wide set compounded by up to 90 variables (depending on the country). We avoid simultaneously using time variables that provide the same information and are likely to be correlated, mitigating the problem of multicollinearity that could otherwise arise. We then start removing the less significant variables from the regressions one by one, until we obtain the final set of variables, all significant in at least one of the regressions and with parameters varying within a reasonable range of values. Once we have selected a preliminary model we test for omitted INF and IC variables.

The robust coefficients of the INF and IC variables in productivity, along with their level of significance, are available upon from request. The parameters estimated in the two step procedure with restricted input-output elasticites can be found in figures 6.1 to 6.23.

[9] Because of the low number of available regions in most of the countries, we had to use the industry-region-size variables instead of the region-industry averages. For the creation of cells a minimum number of firms are imposed—there must be at least 15 to 20 firms in each industry-region-size cell to create the average, otherwise we apply the region-industry averages. If the problem persists, we apply the industry-size or the region-size average.

[10] This two-step estimation approach is a simplified version of an instrumental variable (IV) estimator (two-stage least squares, 2SLS).

[11] Notice that this replacement strategy has a straightforward weighted least squares interpretation since we are giving a greater weight to those observations with more variance (Escribano et al., 2008).

[12] The measurement error introduces a downward bias in the parameters that depends on the ratio between the variances of the variables and the measurement error. Since those explanatory variables are constant within regions, sizes, and industries we expect their variances will be small.

Infrastructure assessment based on O&P decompositions

According to the O&P (1996) decomposition, aggregate productivity for a given country, industry, or region may be decomposed into two terms: (a) average productivity, and (b) a covariance term measuring whether the economy is able to efficiently reallocate resources from less productive establishments to more productive ones. Once we have estimated a robust set of parameters for the IC factors with statistically significant impacts on firms' productivity, we exploit the exact relation, proposed by Escribano et al. (2008a), between the terms of the O&P decomposition, and the IC factors affecting productivity. The IC infrastructure variables affect both the average productivity of African establishments (or firms) as well as their allocative efficiency component. It is well known that competitive markets efficiently allocate resources under certain conditions. But in a world of imperfect information a turbulent IC introduces distortions into markets, and, as a result, affects the efficiency of the economy as a whole. The allocative efficiency term of the O&P decomposition should therefore reflect those imperfections.

In the second part of this analysis—taking advantage of the robustness of the INF, IC, and C elasticities estimated—our aim is to concentrate on the TFP measure that comes from the restricted Solow's residuals in order to evaluate the infrastructure effects on average productivity and on allocative efficiency based on the O&P decomposition of aggregate productivity in levels,

$$TFP_q = \overline{TFP}_q + N_q \hat{\mathrm{cov}}(s^Y_{q,it}, TFP_{q,it}) \cdot \qquad (4.4a)$$

Furthermore, we want to exploit the log-linear properties of the following mixed[13] O&P decomposition for each of the African countries considered in order to obtain closed form O&P decompositions in terms of IC and C variables:

$$\log TFP_q = \overline{\log TFP}_q + N_q \hat{\mathrm{cov}}(s^Y_{q,it}, \log TFP_{q,it}) \cdot \qquad (4.4b)$$

Aggregate log productivity of country *q*, say ($\log TFP_q$), is equal to the sum of the sample average log productivity of the establishments of country *q*, and the covariance between the share of sales (s^Y_q) and log productivity of that country (allocative efficiency of country *q*). The index *q* could also indicate a particular industry, region, size, and so on. The useful additive property of equation (4.2) in logarithms allows us to obtain an exact closed form solution of the decomposition of aggregate log productivity according to equation (4.5). Following Escribano et al. (2008), we can express aggregate log productivity as a weighted sum of the average values

[13] It is called a *mixed* Olley and Pakes (O&P) decomposition because in the original O&P decomposition both TFP and the share of sales were in levels, while TFP in (4.4b) is in logs (log P).

of the IC, dummy D variables, the intercept, and the productivity average residuals ($\bar{u}$) from (4.2), and the sum of the *covariances* between the share of sales and investment climate variables IC, dummies D, and the productivity residuals (u):

$$\begin{aligned}\log TFP_q &= \hat{\alpha}_{INF}\overline{INF}_q\hat{\alpha}_{IC}\overline{IC}_q + \hat{\alpha}_D\overline{D}_q + \hat{\alpha}_p + \overline{\hat{u}}_{q,it} + N_q\hat{\alpha}_{INF}\,\hat{\mathrm{cov}}(s^Y_{q,it}, INF_{q,i}) \\ &+ N_q\hat{\alpha}_{IC}\,\hat{\mathrm{cov}}(s^Y_{q,it}, IC_{q,i}) + N_q\hat{\alpha}_{Ds}\,\hat{\mathrm{cov}}(s^Y_{q,it}, D_i) + N_q\,\hat{\mathrm{cov}}(s^Y_{q,it}, \hat{u}_{q,it})\end{aligned} \tag{4.5}$$

where the set of estimated parameters used comes from the two-step TFP estimation, having the restricted Solow's residual as a dependent variable in (4.2).

From equation (4.5) each INF and IC variable may affect the aggregate log productivity through both its average and covariance (with respect to the share of sales). This complements the information provided by the marginal effects (INF and IC elasticities). Suppose that an INF variable with a low impact—in terms of marginal effects (elasticities)—affects most of the firms in a given country; the impact of such an IC variable in terms of average productivity could be very high. It is therefore very important for policy analysis to combine the empirical evidence from the estimated IC elasticities on productivity with their corresponding INF impact on the two components of O&P decompositions: average productivity and allocative efficiency.

A variable with a negative marginal effect on average productivity (or logTFP) may have either a positive or a negative effect on allocative efficiency. If the covariance of that IC variable and the market share is positive, then the greater proportion of sales in the hands of establishments with high levels of that variable, the larger the negative impact on aggregate productivity will be, therefore decreasing the allocative efficiency. In contrast, a negative covariance means that those establishments with the highest levels of the IC variable have the lowest market shares, and therefore the negative effect of the IC variable on average productivity is somehow compensated through the effect on the reallocation of resources among firms.

By operating in (4.5) Escribano et al. (2008) obtained the next expression, which allows us to obtain a direct decomposition of the impacts of each INF and IC variable on aggregate productivity ($\log TFP_q$):

$$\begin{aligned}100 = \frac{100}{\log TFP_q}[&\hat{\alpha}_{IC}\overline{INF}_q + \hat{\alpha}_{IC}\overline{IC}_q + \hat{\alpha}_D\overline{D}_i + \hat{\alpha}_p + \overline{\hat{u}}_i + N_q\hat{\alpha}_{INF}\hat{cov}(s^Y_{q,i}, INF_{q,i}) \\ &+ N_q\hat{\alpha}_{IC}\hat{cov}(s^Y_{q,i}, IC_{q,i}) + N_q\hat{\alpha}_D\hat{cov}(s^Y_{q,i}, D_i) + N_q\hat{cov}(s^Y_{q,i}, \hat{u}_{q,i})].\end{aligned} \tag{4.6}$$

There are several advantages of using equation (4.6). First, we can compare net contributions by isolating the impact of INF and other IC variables from the impact of industry dummies, the intercept, and the residuals. Second, we can express what portion of aggregate

productivity is explained by INF, IC, and C variables (demeaned log TFP), and what proportion is due to the constant term, industry dummies, and so on. To make cross-country comparisons based on IC impacts on TFP and to avoid the problem of comparing apples and oranges, it is desirable to create an index (demeaned TFP). After subtracting the mean (that is, the constant term, time effects, industry effects, and country-specific effects) from aggregate productivity we can concentrate on the contributions of IC variables to the demeaned TFP.

Similarly, we can construct the demeaned counterparts of expressions (4.5) and (4.6) and compute the percentage contribution of each INF variable or block of IC variables—as in equations (4.7) and (4.8), respectively—obtaining the following *demeaned mixed O&P decomposition*:

$$Demean \log TFP_q = \hat{\alpha}_{INF}\overline{INF}_q\hat{\alpha}_{IC}\overline{IC}_q + N_q\hat{\alpha}_{INF}\,\hat{\mathrm{cov}}(s^Y_{q,it}, INF_{q,i}) + N_q\hat{\alpha}'_{IC}\,\hat{\mathrm{cov}}(s^Y_{q,it}, IC_{q,i}) \quad (4.7)$$

$$100 = \frac{100}{Demean \log TFP_q}[\hat{\alpha}'_{IC}\overline{INF}_q + \hat{\alpha}'_{IC}\overline{IC}_q + N_q\hat{\alpha}_{INF}\hat{cov}(s^Y_{q,i}, INF_{q,i}) + N_q\hat{\alpha}_{IC}\hat{cov}(s^Y_{q,i}, IC_{q,i})]. \quad (4.8)$$

So far, we have exploited the linear properties of the logarithm form of the mixed O&P decomposition of TFP. But the original O&P decomposition is based on TFP and the share of sales (in levels), and is therefore also capturing nonlinear relations between market shares and IC variables coming from (4.3a). To know to what extent these nonlinear terms are affecting this relation, we perform simulation experiments[14] on INF, IC, and C variables, and evaluate the consistency of the results with the ones obtained from the previous mixed O&P decomposition—see (4.4b). The IC simulations are done variable by variable (one at a time) keeping the rest of the variables constant; that is, we propose a scenario in which the level of one of the IC variables improves by 20 percent in all establishments (20 percent less power outages, 20 percent less shipment losses, etc). We compute the corresponding rate of change of aggregate productivity, average productivity, and allocative efficiency caused by such a 20 percent improvement. We repeat the same experiment for the rest of the IC and C variables, and, for comparative purposes, we also evaluate the relative group of IC variables.

5. The contribution of infrastructure to the investment climate (IC) of Africa

In section 4 we described the econometric methodology used in section 6 to assess the impact of infrastructure on productivity. We suggested three key elements of empirical evaluations of infrastructure and other IC and C impacts on productivity: the marginal productivity effects, the percentage contributions of infrastructure to aggregate log productivity (mean and efficient

[14] We are indebted to Ariel Pakes for this suggestion.

components), and the simulations of infrastructure improvements on aggregate productivity (in levels).

In this section we focus on presenting the results of infrastructure contributions to aggregate productivity from simulation experiments. In addition to the results of the econometric analysis, we consider African firms' perceptions of the main obstacles to economic performance. In the first subsection the objective is to assess how African firms perceive infrastructure quality. This is followed in the next subsections by the results of the econometric analysis, focusing on the infrastructure's effect on productivity after controlling for other IC factors. Finally, to complement the robustness of the results we check the consistency of the conclusions obtained from both the IC contributions to average log TFP and from the TFP simulation experiments.

Do African firms perceive infrastructure as an obstacle to growth?

In ICSs, firms are asked to rate a number of IC factors as obstacles to economic performance. The survey options offered are *no obstacle*, *minor obstacle*, *moderate obstacle*, *major obstacle*, or *very severe obstacle* on a broad range of IC aspects: infrastructure, red tape, corruption and crime, finance, and labor skills.

Figure 5.1 (see appendix 3) shows the degree to which each group of IC factors is perceived by firms as an obstacle to economic development. These perceptions are sorted in descending order by their perceived contribution to the total, after being normalized to 100. For example, in panel A of figure 5.1, we observe that in Cape Verde 25 percent of firms believe infrastructure to be a major or very severe obstacle to economic growth; 40 percent find red tape, corruption, and crime as a major or very severe obstacle; 23 percent finance; and 10 percent a lack of labor skills. The countries in which infrastructure is perceived as an especially great obstacle to growth are—in descending order—Cape Verde, Burundi, Burkina Faso, Mauritania, Cameroon, Ethiopia, and Niger. Countries where a relatively low number of firms perceive infrastructure as a major constraint are Egypt, Mauritius, Morocco, South Africa, and Botswana.

[FIGURE 5.1 ABOUT HERE]

The factor group with the largest number of subfactors is red tape, corruption, and crime. So it is not surprising that this has the largest percentage of all. In order to isolate this effect, we normalize after computing the mean of each IC factor type. For example, in the infrastructure group there are four IC subfactors (telecommunications, customs, electricity, and transportation), whereas the red tape group contains eleven subfactors. But the importance of

infrastructure is very similar across countries, although obviously the relative contribution of the red-tape group is more balanced, gaining relatively more relevance to the other IC groups.

In the next subsection the results of the econometric analysis—estimating the relative impact of infrastructure on average productivity using simulations—are compared with firms' perceptions of obstacles to growth. The question of interest is: are the econometric results consistent with firm perceptions?

Impact of infrastructure on productivity

The impact of infrastructure factors on productivity are evaluated here in terms of their effect on the O&P decomposition. Infrastructure's contribution to the aggregate productivity of each country's manufacturing sector is decomposed into its contribution to (a) average productivity and (b) allocative efficiency (the ability of markets to reallocate resources from less productive to more productive establishments).

[FIGURE 5.2 ABOUT HERE]

Figure 5.2 presents the two alternative country-by-country O&P decompositions given by equations (4.4a) and (4.4b), sorted by aggregate productivity in descending order. The productivity measure used to calculate the O&P decomposition is the restricted Solow residual obtained from the two-step estimation approach (see section 4). We present two sets of results with O&P decompositions. Panel A of figure 5.2 shows the O&P decomposition with the restricted Solow residual in levels, and panel B shows the mixed O&P decomposition with the restricted Solow residual, in logs, weighted by the share of sales. This is important because the results of the simulations are associated with the O&P decomposition in levels, and the results from the percentage contributions to the average use the convenient additive property of the TFP equation in logs. Notice that both panels A and B preserve the rankings of average productivity, but this is not necessary true for aggregate productivity. The reason is clear: aggregate productivity is simply the sum of average productivity and allocative efficiency, and this second term depends somewhat on whether we use TFP in levels or in log form.[15] From panel A of figure 5.2 we observe a positive reallocation of output. That is, output is moving from less productive establishments to more productive ones, since in all the countries the allocative efficiency is positive, with the greatest effects found in Benin, Burkina Faso, Cameroon, Niger, and Eritrea.

Notice that we avoid direct comparisons of TFP across countries but we suggested in section 4 to compare demeaned productivity decompositions (see figure 5.2, panels A and B, in

[15] For a deeper discussion of this issue see Escribano et al. (2008).

the appendix). Remember that the demeaned productivity (or demeaned TFP) at the firm level is simply firm-level productivity minus the constant term of the productivity equation and the industry and year dummies (see equation 4.7).[16] We assume that all the productivity differences resulting from units of measurement, different deflators, and so on are contained in the constant, industry, and time-fixed effects, and therefore what is left in the productivity measure are only the TFP effects of the infrastructure, IC, and other C variables.

[FIGURE 5.3 ABOUT HERE]

We obtain the O&P decomposition using the demeaned productivity either in levels or in logs. This demeaned TFP set of cross-country comparisons is presented in figure 5.3 (see appendix 3). Panel A shows the decomposition of the demeaned productivity in levels; it is interpreted as the productivity that stems from IC conditions after controlling for all the other elements. The results are not at all surprising since they are basically consistent with those provided by the per capita income and by the DBR (2007). Rankings based on demeaned productivity are topped by South Africa and Mauritius, closely followed by Botswana, Algeria, Egypt, Namibia, and Swaziland. The lowest-ranked countries are those with the most antiproductive IC, in other words, those whose IC conditions pose difficulties to economic development. These countries are Tanzania, Malawi, Uganda, Benin, Mauritania, and Zambia. Symmetrically, as for the regular O&P decompositions, the contribution of the IC to aggregate demeaned productivity is decomposed into its contributions to average demeaned productivity and the allocative demeaned efficiency term (see equation 4.7). Notice that, in Africa, the allocative efficiency component is always lower than the effect of average productivity. Nevertheless, in Madagascar, Botswana, Mauritius, and other countries, the IC has a considerable effect on the efficient reallocation of resources among establishments.

Alternatively, this demeaned productivity may be interpreted as a sum of pro- and antiproductive infrastructure, as well as other IC and C factors. Examples of proproductive infrastructure factors are the use of e-mail and websites. Negative or antiproductive infrastructure factors include the number of power outages, the average duration of water outages, and so on. As a consequence, productivity will decrease as the importance of antiproductive factors becomes larger and larger; this picture becomes even clearer in panel B of figure 5.4 (see appendix 3). The demeaned O&P decomposition of TFP in logs (see panel B) shows how aggregate productivity may be negative (in Tanzania, Benin, Malawi, and so on) when the negative TFP aspects of IC dominate over the positive (proproductive IC factors weigh

[16] Obviously, the year dummies are only subtracted from the productivity measure of the countries with panel data.

more than the negative ones), as in the case of South Africa, Mauritius, Egypt, Botswana, and so on.

In sum, in African countries the IC has important effects on the aggregate productivity of the manufacturing industry, and this net effect may be positive or negative depending on which IC aspect matters more—the proproductive or the antiproductive. The aim now is to know to what extent such decreases or increases in productivity are due to infrastructure or other IC groups.

[FIGURE 5.4 ABOUT HERE]

Figure 5.4, panel A, provides the decomposition of demeaned productivity in levels using simulations of improvements to IC variables. When the IC factor improves by 20 percent it could mean, for example, that 20 percent more firms are using e-mail, or that there is a 20 percent reduction in power outages, and so on—which implies decreases in the negative IC factors and increases in the positive ones. The total effect of improving each IC by 20 percent, maintaining the rest of IC factors constant, implies that aggregate productivity could increase in South Africa by 55 percent, in Mauritius by 30 percent, and so on. From panel A of figure 5.4 it is clear that there are some economies that are more likely to be affected by the IC. These are therefore more sensitive to changes in IC conditions. This is the case in Kenya and Benin, where the aggregate productivity could increase by 70 percent and 85 percent, respectively. At the other extreme are Egypt, Morocco, and Eritrea. Lastly, improvements to aggregate productivity come in almost all countries via improvements to average productivity, and, to a lesser extent, allocative efficiency, with the exception of Algeria, Kenya, and Benin. The role of infrastructure in the composition of aggregate productivity is considerable in all the countries, but is the greatest in Uganda, Benin, Malawi, Cameroon, and Zambia. This suggests that these countries are the most sensitive to changes in infrastructure quality.

Panel B of figure 5.4 shows a more static interpretation using the O&P decomposition in logs by group of variable. In particular, panel B offers information on the actual and current situation of the IC and its effect on aggregate productivity; in other words, gains and losses generated by the average IC conditions (O&P decomposition of TFP in logs decomposed by groups of INF, IC, and C variables). For example, in South Africa, aggregate *demeaned* TFP is 0.83 (see panel B of figure 5.3). Out of this level of productivity -0.9 is explained by the overall contribution of the infrastructure factors; 0.95 by red tape, corruption, and crime; and the rest by the remaining IC and C variables. Notice that in panel B the contributions of the different groups are not in absolute value, so the positive effect of the proproductive factors compensate for the negative effect of the antiproductive ones. Even taking this into account, the overall

contributions of the infrastructure group are negative in all the countries, implying that the proproductive infrastructure IC factors never compensate for the negative IC effects, with the exception of Kenya (where it is slightly positive) and Madagascar, Ethiopia, and Algeria (where the contribution of the infrastructure group is close to zero and almost negligible). As expected, the largest and most negative infrastructure effect is found in Benin, followed by Malawi, Uganda, Mauritania, Cameroon, and Zambia.

[FIGURE 5.5 ABOUT HERE]

Continuing with the same idea in figure 5.5, we are interested in obtaining the weight of the infrastructure group relative to the IC as a whole. Thus, by normalizing to 100 the contribution of the IC to aggregate productivity, average productivity, and allocative efficiency, we find via simulations that the relative 20 percent improvement of infrastructure in Malawi reaches 58 percent, in Eritrea 50 percent, and in Uganda 45 percent (as panel A of figure 5.5 shows). The same holds for average productivity (panel B) where the rankings do not change, and for allocative efficiency (panel C), where, once again, Malawi, Senegal, and Uganda show the largest contributions of the infrastructure group.

[FIGURE 5.6 ABOUT HERE]

A similar picture is provided by figure 5.6, where, instead of simulations, we consider the relative contributions by groups of variables to average demeaned log productivity and to the demeaned efficiency term—see equation (4.8). In this case we sum up the different contributions of the INF, IC, and C factors of equation (4.8), but in absolute value so that the negative effects do not compensate for the positive ones and vice versa, and we compute the relative contribution of each group within the IC group as a whole. Therefore, the relative contribution of the infrastructure group is the sum in absolute value of all individual infrastructure variables divided by the total absolute contribution of all INF and IC variables—multiplied by 100. The largest relative effects of infrastructure on aggregate log productivity are found in Malawi (60 percent), Uganda (50 percent), Benin (50 percent), Zambia (47 percent), and Ethiopia (46 percent). The lowest contributions are in Kenya, Swaziland, and Botswana. A similar ranking is provided by panel B, where the effects on the average log productivity are isolated from those from the allocative efficiency, as seen in panel C. Once again, Malawi, Benin, Senegal, Uganda, and Ethiopia lead a ranking closed by Mauritius, Egypt, Swaziland, Botswana, and Namibia. Panel C offers the results for allocative efficiency. In Malawi, Senegal, Namibia, and Algeria, the effects of infrastructure on the efficient reallocation of results among

firms appear to be very significant, reaching the relative contributions of 54 percent, 48 percent, and 46 percent, respectively.[17]

Cross-country comparisons

Table C.1 summarizes the empirical results discussed in previous sections. The first column shows ranking of African countries based on per capita income, the second based on the DBR (2007), the third column based on quality of overall infrastructure (1 minimum, 7 maximum) given in the ACR (2007), the fourth column the demeaned aggregate productivity, and the fifth column shows the ranking of firms' perceptions of the quality of infrastructure (from 23rd being the poorest quality to 1st being the best quality in our sample). Columns 6 and 7 show the percentage of absolute contributions of infrastructure to average log productivity and to allocative efficiency, with TFP in logs, while columns 8 and 9 show the percentage absolute contributions of infrastructure to average productivity in levels and to allocative efficiency via simulations.

[TABLE C.1 ABOUT HERE]

The rankings presented in the first five columns are very consistent. In particular, the ranking based on demeaned aggregate productivity (column 4) shows a clear positive correlation to per capita GDP and with the ranking based on the DBR rankings. From the results of the rankings obtained from the first five columns we find two groups of African countries, as was suggested by looking at the growth rates of per capita GDP (see figure 1.2, panel B). That is: (a) countries in the north and south of Africa are relatively more successful, and (b) countries from the central-east and central-west regions of Africa are relatively less successful.

The last four columns show two alternative measures of the percentage absolute contribution of infrastructure to productivity, along with the ranking in parentheses. In particular, column 6 shows a negative correlation between the ranking based on the contribution of IC to average log TFP and per capita GDP and also with the ranking based on the DBR, indicating that low infrastructure quality is one of the key growth bottlenecks in Africa. The results show a great homogeneity among the rankings in the first four columns and the

[17] It is useful to clarify that the differences between the rankings of the contributions to the aggregate productivity via simulations of panel A of figure 5.5 and the rankings of the contributions to the aggregate log productivity of panel A of figure 5.6 come mainly from the role of the allocative efficiency. Notice that in figure 5.6 the allocative efficiency term based on log TFP does not have the same scale as the efficiency term when TFP is in levels. As a result, since aggregate productivity is simply the sum of the average productivity and the efficiency term in levels, the role of the efficiency term with TFP in levels will increase with respect to its counterpart in logs and therefore, could alter the rankings of countries based on the two alternative measures of aggregate productivity (weighted productivity).

results from the econometric analysis. Thus, for instance, Mauritius is ranked 1st in terms of per capita income and quality of overall infrastructure in the ACR (2007), 2nd according to the DBR (2007) and firms' perceptions, 19th (out of 23) according to the impact of the INF variables on the average log productivity, and 18th (out of 23) with respect to the allocative efficiency in logs. In these cases the correlation with firm growth is negative, signaling again that infrastructure quality is an important growth bottleneck in Africa.

Egypt and Morocco are interesting cases. Both countries show a relatively high quality of infrastructure according to the ACR and perception rankings, and the results of the econometric analysis confirm this. Egypt is 4th and Morocco is 5th in the rankings based on demeaned aggregate productivity, and both have one of the lowest contributions of infrastructure to TFP.

Countries with the poorest infrastructure quality, according to ACR (2007) and firms' perceptions, are Cameroon, Burkina Faso, Niger, and Ethiopia. Once again this is consistent with the econometric analysis done for these countries, showing a great negative influence of infrastructure on productivity. Cameroon and Burkina Faso are ranked among the countries with the highest contribution of infrastructure to average productivity. The influence of infrastructure on Ethiopia's manufacturing sector productivity is also very high, with a relative contribution equal to 52.6 percent of the total IC effect.

The following set of figures provides some additional evidence on the relation between measures of countries' economic performance and TFP based on our econometric analysis. The previous conclusions become more apparent by looking at the cross-plots. Figure 5.7 shows a clear positive correlation between GDP per capita and demeaned aggregate productivity, with a correlation coefficient equal to 0.81. Notice that this positive relationship has a decreasing dispersion as per capita income grows; that is, for those African countries with a per capita GDP lower than 10 percent of that of the United States, demeaned aggregate productivity presents a more heterogeneous behavior. The conclusion obtained from figures 5.8 and 5.9 are similar. Those countries that are high in the ranking based on ease of doing business (DBR) also have a large demeaned aggregate productivity, with a correlation coefficient of 0.77. The same is true for the positive relationship between the quality of overall infrastructure and the ACR (2007)—the more productive the manufacturing firm is, the higher the contribution of overall infrastructure quality to TFP (correlation coefficient equal to 0.76).

A question of interest is whether those countries with the lowest demeaned aggregate productivity levels are also those with the greatest impact of infrastructure on firm's perceptions, on average productivity, and on allocative efficiency. Figures 5.10 and 5.12 provide clear answers to these questions. Figure 5.10 shows the negative correlation between the mixed demeaned aggregate productivity and firm's perceptions of growth bottlenecks, with a correlation coefficient of 0.76. The absolute contribution of infrastructure to both average log

productivity and average productivity via simulations decreases as the demeaned aggregate productivity increases. This relation is stronger in the case of the absolute percentage contribution to the average log productivity since the corresponding coefficients of correlations are -0.60 (figure 5.11) and -0.49 (figure 5.12).

[FIGURES 5.7 TO 5.12 ABOUT HERE]

Figures 5.13 and 5.14 show the linear correlations between demeaned aggregate productivity and percentage absolute contribution to allocative efficiency TFP in logs and allocative efficiency via simulations, correspondingly. There is a negative relation in both figures. But the linear correlation is smaller in the case of the average log productivity (correlation coefficient equal to -0.31) than in the case of allocative efficiency with TFP in levels (correlation coefficient equal to -0.49).

Finally, figures 5.15 and 5.16 show the strong linear positive relation between the infrastructure contributions to the two components of the O&P decomposition based on TFP in logs and TFP in levels. Their corresponding coefficients of correlation are 0.69 and 0.77, respectively.

[FIGURES 5.13 TO 5.16 ABOUT HERE]

All effects of infrastructure are not supposed to be negative in all cases. There are positive factors intended to stimulate productivity and economic activity, such as the use of ICT or a firm's own electricity generator. A question of interest is to what extent the impacts listed in table 5.1 are due to positive factors that enhance economic performance or negative factors that constrain economic activity. Since the absolute percentage contributions are constructed based on absolute values, at this point we still cannot say anything about the direction of the effect of infrastructure on economic performance. But it is easy to analyze the effect of the individual INF factors, and this is one of the aims of the following section.

6. Country-by-country results

In the preceding section we evaluated the relative weight of infrastructure among IC variables. In this section the objective is to present a summary of the main results, country by country, focusing on the impact of the individual infrastructure factors or variables. We measure the strength of infrastructure's impact on TFP through three different procedures: (a) elasticities or semi-elasticities, (b) simulations, and (c) evaluation of the IC regressions impact on the sample mean of the variables.

These three sets of results provide complementary information. The elasticities and semi-elasticities measure the impact of a change in an independent variable (infrastructure factors or other IC and C variables) on the dependent variable (productivity). But elasticities and semi-elasticities are not directly comparable.

On the other hand, simulations measure how the dependent variable changes from scenario A, in which the infrastructure and other IC and C factors are as observed by the survey, to scenario B, in which one of the infrastructure factors improves by, say, 20 percent. From this we can make the following assertions: *If the number of power outages suffered by firms in country* X *is reduced by 20 percent, then the average productivity (or the allocative efficiency) could increase by* Y *percent, holding everything else constant*.

Finally, the evaluation at the sample means of the regression variables, as opposed to the simulations, is a static exact decomposition of the terms of the mixed O&P decomposition. We can evaluate the contributions of all the INF, IC, and C factors to the sample mean of average log productivity, identifying the relative importance of each infrastructure variable (for example, losses due to the number of water outages or transport failures) in net terms or in absolute terms.

The next subsection focuses on the results of each of the 23 countries. The results are presented in a series of country-specific figures 6.1–6.23. The figures also report the results for the productivity equation. The first panel of each figure shows the elasticities and semi-elasticities; the second and third panels focus on the relative contribution of the INF variables to the average log productivity and to the allocative efficiency in logs; and the fourth and fifth panels present the results of the simulations (that is, how much the average productivity and the allocative efficiency would increase if we improve the INF variables).

Note that the results on the elasticities and semi-elasticities are not comparable since they use different measurement scales. For purposes of comparison we should rely on the simulations and on the results of the contributions to the average.

In the interest of space, we focus only on the major results for each country.

[FIGURES 6.1 TO 6.23 ABOUT HERE]

6.1 Infrastructure impacts on TFP by country

High-growth countries in southern Africa

Mauritius (MUS). Mauritius is the top-ranked in terms of per capita GDP and demeaned aggregate productivity, and the second according to the DBR (2007) and firms' perceptions of

the quality of infrastructure (table 5.1). The relative contribution of infrastructure to average log productivity is 26.6 percent—one of the lowest among the African countries considered (see figure 5.5, panel B, and figure 6.14, panel B). The most important constraint on productivity comes from the number of days to clear customs for exports (17 percent on average) (see figure 6.14); 5.2 percent is due to the use of IC technologies (positive factor); and low-quality provision of electricity and water accounts for only 2 percent of the average log productivity.

Swaziland (SWZ). Swaziland is ranked second in terms of per capita GDP (table 5.1). Productivity of firms is negatively affected by shipment losses in customs, the number of power outages, and the average duration of transport by road (see figure 6.20). These results are common to Namibia and Botswana since the countries are pooled together for estimation. The use of generators has a positive sign, meaning that it stimulates productivity. Country-specific results for Swaziland show that the largest contribution to average log productivity comes from problems in customs during the export process (10 percent), and from the number of power outages (9 percent).

South Africa (ZAF). South Africa is ranked third based on per capita GDP and demeaned aggregate productivity (table 5.1). Productivity is negatively affected by the days to clear customs to import, the sales lost due to power outages, the number of water outages, the time waiting for an electricity supply, and sales lost due to delivery delays. Therefore, the low quality of the customs services, electricity services, and water affects productivity performance at the firm level in South Africa. The contribution to average log TFP of electricity provision is 6.9 percent, and the contribution of water provision is 5.7 percent. Time wasted in customs while importing accounts for 9.4 percent of the average log productivity. Lastly, problems in transport services represent 5.7 percent of average log productivity (see figure 6.19).

Botswana (BWA). Botswana is ranked fourth based on per capita income (DBR, 2007) and on perceptions and sixth in terms of demeaned aggregate productivity. The productivity of firms located in Botswana is affected by shipment losses in customs while exporting (negative), power outages (negative), the percentage of electricity that comes from firm's own generators (positive), and the average duration of transport by road (negative) (see panel A of figure 6.3 and panel B of figure 5.5). These marginal effects are common to Namibia and Swaziland since the countries are pooled together for estimation. Country-specific results show that the largest contributor to both average log productivity and to allocative efficiency is shipment loss in customs while exporting (panel B). Simulations show that the largest productivity improvement comes from reduction in power outages (panel D of figure 6.3). That is, according to our simulations, if the number of power outages suffered by firms in Botswana were reduced by 20 percent, average productivity could increase by 2.1 percent.

Namibia (NAM). Namibia is ranked sixth in terms of per capita GDP and ACR (2007) (table 5.1). Productivity of firms is negatively affected by shipment losses in customs while exporting, the number of power outages, and the average duration of transport by road (see figure 6.16). These results are common to Botswana and Swaziland since the countries are pooled together for estimation. Country-specific results show that the impact of infrastructure on the productivity of manufacturing firms in Namibia mainly comes from problems in customs while exporting—this factor represents 9 percent of the average log productivity. Problems from electricity provision (power outages) and from use of alternative power infrastructure (such as a generator) represent 2.2 percent and 3 percent of the average log productivity, respectively, in absolute terms (figure 6.16).

High-growth countries in North Africa

Algeria (DZA). **Algeria is ranked fifth in terms of per capita GDP, and seventh in terms of firm perceptions and demeaned aggregate productivity**. The results on the **productivity impact** of infrastructure (see figure 6.1) show the total effect on absolute value is as large as 48.6 percent of average log TFP. The quality of infrastructure variables affecting TFP are: cost of exports, having an own generator, number of power outages, losses due to water outages, having an own well, the cost of water from the public system, having e-mail, and low-quality supplies. The largest and most positive effect comes from having e-mail, which could represent 14.5 percent of average log TFP.

Egypt (EGY). Egypt is ranked seventh based on per capita GDP, sixth in terms of ACR (2007), fourth in terms of demeaned aggregate TFP, and third in firms' perceptions of infrastructure quality. From the econometric analysis, the contribution of infrastructure to the average log productivity in Egypt is only 26 percent. The main infrastructure factors affecting firms' productivity are the average duration of water and power outages (both with negative effects), the percentage of firms with their own generator (positive effect), the dummy for own transportation (positive), shipment losses in exports (negative), and days of inventory of the main supply (negative) (figure 6.6).

Morocco (MAR). The perceptions of the managers of the Moroccan firms suggest that infrastructure is not a major concern when compared to other IC constraints; it is ranked first in table 5.1. But according to figure 6.15, the contribution of infrastructure to average log productivity is 31.3 percent, with the largest impacts coming from (a) the average time to clear customs to import, and (b) the time wasted to obtain a phone connection. A 20 percent reduction of average customs delays for imports could increase average productivity by 1.6 percent and allocative efficiency by 0.4 percent. Notice, that the ranking based on the

econometric analysis (demeaned aggregate productivity) is consistent with the ranking based on per capita GDP (see table 5.1), which establishes that Morocco is in eighth position, not first.

Low-growth countries in central-west Africa

Cameroon (CMR). Cameroon is rank ninth in term of per capita GDP, which is somehow surprising if we compare it with the results of the rest of the rankings based on DBR (2007), ACR (2007), firms' perceptions, and demeaned aggregate productivity. We found that the productivity of manufacturing firms in Cameroon is reduced by the following factors: number of days required to clear customs for imports, average duration of power and of water outages, shipment losses, and time waiting for a phone connection (panel A of figure 6.5). These factors are common to Mauritania, Burkina Faso, and Niger since the countries are pooled together for estimation purposes. Country-specific results show that the largest contributions to average log productivity come from the number of days waiting to clear customs, duration of power outages, and from the time waiting for a phone connection (panel B of 6.5). Infrastructure represents 41.6 percent of average log TFP.

Mauritania (MRT). Mauritania ranks 10th in terms of per capita GDP, 13th in term of the total absolute contribution of infrastructure to average log productivity, 17th in terms of firm perceptions, and 15th in terms of demeaned aggregate productivity. These results are common to Burkina Faso, Cameroon, Niger, Ethiopia, and Eritrea since those countries are pooled together for estimation purposes. Delays in customs while importing represent 22 percent of average log productivity and 12 percent of allocative efficiency. In terms of simulation, a 20 percent improvement in this variable could cause a 13.9 percent increase in average productivity and a 7.8 percent one in allocative efficiency. Low-quality provision of electricity and water and its indirect costs also reduce average productivity in Mauritania (see figure 6.13).

Senegal (SEN). Senegal reveals a high infrastructure impact on the TFP of manufacturing firms. The percentage contribution of infrastructure to the average log productivity of this country is 58.5 percent; the indirect costs stemming from the low-quality provision of electricity represent 9.3 percent of this (see figure 6.18). The use of own-power infrastructure partially alleviates the negative impact of the low quality of electricity provision. The relative importance of problems in transport services (such as low-quality supplies) is very high; this variable represents 23.4 percent of average log productivity and 14 percent of allocative efficiency. A 20 percent reduction in the percentage of low-quality supplies received may cause a 3.2 percent increase in average productivity. Notice that the simulation of a 20 percent improvement in the percentage of low-quality supplies received causes a decrease in allocative efficiency of -0.4 percent. The reason for this phenomenon is clear: the allocative efficiency is simply the

covariance between productivity at the firm level and share of sales. Therefore, a negative rate of change of the allocative efficiency indicates that the firms receiving a larger share of low-quality supplies are those with the largest market shares.

Benin (BEN). Benin is ranked 12th in per capita GDP, 11th in terms of demeaned aggregate productivity, and 13th in terms of DBR (2007). The time waiting for phone connections and to clear customs in order to export are the two factors that most negatively contribute to average log productivity (see panel B of figure 6.2). An independent 20 percent improvement in these two variables could increase average productivity by 3.8 percent and 4.3 percent, respectively (panel D of figure 6.2). The same holds for the allocative efficiency term (panels C and E).

Mali (MLI). Mali is ranked 14th in per capita GDP terms, in demeaned aggregate productivity, and in the ACR (2007). The total contribution of infrastructure to average log productivity in Mali is 42.7 percent. The low quality of electricity, water, and phone provision accounts for almost 32 percent of the average log productivity. The use of firms' own roads is a factor that increases productivity (figure 6.12).

Burkina Faso (BFA). Burkina Faso ranks 16th and 12th in terms of per capita GDP and demeaned aggregate TFP, respectively. The main infrastructure problems are clearing customs while importing, the average duration of power and water outages, shipment losses, and time waiting to obtain a phone connection. These results are common to Mauritania, Cameroon, and Niger since these countries are pooled for estimation. In particular, for Burkina Faso, all of these factors reduce productivity at the firm level (see figure 6.4) and can contribute to 35 percent of average log TFP.

Niger (NER). Niger is one of the poorest countries in our sample: it ranks 19th based on per capita income, and managers' perceptions show a great concern regarding quality of current infrastructure (20th in the rank). The absolute contribution of infrastructure to average log productivity is 34.7 percent, with 20.7 percent due to problems clearing customs while importing, 9.4 percent due to the average time wasted in obtaining a phone connection, and 4.5 percent due to the cumulated negative effect of the low-quality provision of electricity and water and the poor transport system (see figure 6.17).

Low-growth countries in central-east Africa

Kenya (KEN). Kenya ranked 13th in per capita GDP, 6th in terms of DBR (2007), and 8th in terms of demeaned aggregate productivity. The results of the productivity equation in Kenya show multiple interrelationships between productivity at the firm level, on one hand, and infrastructure, on the other. Factors such as the use of generators, the cost of electricity from the public grid, water outages, sales lost due to power outages, and so on, reduce productivity

at the firm level (see figure 6.9). Although the contribution to the average log productivity of any of these factors is over 6 percent, infrastructure as a whole accounts for 30 percent of average log productivity, and for 19.9 percent of allocative efficiency (which illustrates the major influence infrastructure has on Kenyan firms' productivity).

Uganda (UGA). Uganda is ranked 15th in per capita GDP and 17th in demeaned aggregate productivity. Uganda's average log productivity is strongly influenced by infrastructure conditions, representing 58.4 percent. The two main factors affecting average productivity are the time to clear customs and the provision of electricity (figure 6.22, panel D).

Zambia (ZMB). Zambia ranks 17th in terms of per capita GDP, 14th in terms of firm perceptions, and 18th in terms of the ACR (2007) .The contribution of the cost of electricity from the public grid to average log productivity in Zambia is 32.5 percent. The contribution of the average duration of power outages to average log TFP is 9.1 percent (see figure 6.23). The total contribution of infrastructure to average TFP is 50.6 percent.

Tanzania (TZA). Tanzania is 18th based on per capita GDP, 14th in terms of DBR (2007), and 15th in terms of firm perceptions. The absolute contribution of infrastructure to average log productivity in Tanzania is 34.1 percent. Out of this, 14.8 percent is due to time wasted waiting for water supply and 5.5 percent is due to the number of transport outages (figure 6.21).

Malawi (MWI). Malawi is ranked 20th in per capita GDP terms and 22nd in terms of ACR (2007). The econometric evidence shows that the aggregate productivity of Malawian's manufacturing firms are dramatically affected by infrastructure quality (83 percent of average log TFP). Delays in clearing customs while importing account for 25 percent of the average log productivity. A 20 percent improvement in this variable could increase the average productivity by 6 percent and the allocative efficiency by 1.5 percent (see panels D and E of figure 6.11). Symmetrically, productivity decreases as the number of power outages increases; the percentage contribution of this variable to average log productivity is 9.2 percent and to the allocative efficiency is 3.5 percent. The cost of electricity from firms' own generators is another antiproductive factor. Water provision also impacts the productivity of Malawian firms (figure 6.11).

Madagascar (MDG). Madagascar is ranked 21st in per capita GDP terms, and 16th and 17th in terms of demeaned aggregate productivity and DBR (2007), respectively. How infrastructure may impact firm-level productivity is clear from the results obtained in figure 6.10. The factors related to electricity supply are intimately linked to productivity. Water costs and the number of phone outages also reduce productivity at the firm level. The total contribution of infrastructure to average log productivity in Madagascar is 31 percent and to allocative efficiency is 28 percent.

Ethiopia (ETH). Ethiopia is ranked 22nd in terms of per capita GDP and 21st in terms of firms' perceptions. The productivity of Ethiopian manufacturing firms is negatively affected by the days to clear customs to import, the cost of electricity from the public grid, shipment losses while in transit, and the percentage of supplies that are of lower than agreed-upon quality. Positive effects on productivity come from the percentage of electricity from firms' own generators and from the days of inventory of the main supply. These results are common to Eritrea since the countries are pooled together for estimation. The largest contribution to the average log productivity is by the days of inventory of main supply, days to clear customs to import, the cost of electricity from the public grid, and the electricity from firms' own generators (figure 6.8). In total, infrastructure represents 32 percent of average log TFP, which seems too low. This might indicate that pooling with Eritrea for estimation of IC elasticities might not be a good idea in this case.

Eritrea (ERI). Eritrea is the last country in the ranking, in 23rd position in terms of per capita GDP. The total number of days waiting to clear customs to import, the cost of electricity from the public grid, shipment losses, and low-quality supplies are the factors with negative effects on firms' productivity (see figure 6.7). Remember that these results are common to Ethiopia since the countries are pooled together for estimation. The cost of energy from the public grid accounts for a 22.9 percent of average log productivity, almost 50 percent more than the second factor (days to clear customs to export) in order of importance. In total, infrastructure represents 48 percent of average log TFP.

6.2 Summary of the main empirical results

The aim of this subsection is to summarize the main empirical results obtained, country by country, including the absolute percentage contribution of the infrastructure group of variables to the sample means of productivity in logs. The *customs clearance* subgroup includes those variables related to the ease or difficulty of clearing customs when exporting or importing. Within *provision of electricity* we have grouped all the variables related to low-quality provision of electricity (number of power outages, power fluctuations, cost of electricity, and so on). *Use of power infrastructure* is intended to enclose all the variables related to the use of alternative sources of energy, such as generators. Similarly, the subgroups *provision of water* and *provision of phone connections* includes all the variables related to the quality of the provision of these utilities, whereas *use of water infrastructure* includes the use of firms' own wells or boreholes to replace the public provision of water. Obviously, *use of ICT* takes into account the use of ICT in firms' commercial operations. Lastly, *transport services* contains all variables relating to the quality of transportation services, such as shipment losses in transit, transport delays, delivery

delays, and so on. *Own transport infrastructure* includes the use of own transportation for products or workers.

Figure 6.24 shows the prominent influence of low-quality electricity provision on average log productivity in the different countries considered in this report. The percentage absolute contribution of this group of variables to average log productivity ranges from 34.1 percent in Zambia to 0.3 percent in Morocco, being a negative effect in all cases. Only in Tanzania was the low quality of electricity provision not statistically significant, probably due to the significant and very influential effect of water provision in this country. The low quality of electricity and the continuous outages are partially alleviated by the use of own-power infrastructure, as the positive effect of the group *use of power infrastructure* shows.

Another group of variables with a statistically high impact on average log productivity is *customs clearance.* The contributions of this group are negative and very large in most countries, indicating a clear and pervasive constraining effect of the time wasted in customs when importing or exporting.

[FIGURES 6.24 ABOUT HERE]

Regarding *provision of water*, the relative importance of this group of variables is lower when compared to the *provision of electricity*; nevertheless, there are some cases (such as Tanzania, Mali, and Kenya) where the contribution of this group of variables is very high, even compared to the provision of electricity. As with the provision of electricity, the use of alternative water infrastructure such as boreholes or wells has a positive impact on plants' productivity—an effect that only appears to be significant when there is a negative effect of water provision, suggesting the existence of a replacement effect between the public provision of water and alternative supplies of water.

The poor quality of phone provision is negatively related to productivity in 14 countries; nevertheless, the quantitative contribution of this group of variables is, in general, lower than the impact of the electricity provision. Benin is an exception. The contribution to the average log productivity of telephone provision in this country is 40.8 percent—more than 20 times the contribution of electricity provision, which is only 2 percent. The use of IC technologies is positively related to productivity, but the use of these technologies was only significant in the productivity regressions of six countries: Malawi, Algeria, Tanzania, Kenya, Morocco, and Mauritius, with the largest impacts in Algeria (14.5 percent) and Mauritius (5.2 percent).

Problems with product transport are negatively related to productivity in all the cases, with the exception of Botswana, Swaziland, and Namibia, for which no variables for this group were significant in productivity regressions. The largest impacts of this subgroup of variables were seen in Senegal, Tanzania, Madagascar, South Africa, and Zambia; nevertheless, the

contributions of transport services to average log productivity are relatively lower than the impact of the *provision of electricity* or the *customs clearance* subgroups. On the other hand, the use of own-transport infrastructure stimulates productivity growth; in all the cases in which any variable belonging to this subgroup was significant in the productivity regressions, it appeared with a positive sign. But the positive effects on productivity of these factors were concentrated in only seven countries: Malawi, Benin, Senegal, Eritrea, Tanzania, Kenya, and Egypt.

Figure 6.25 provides similar information, but, in this case, we have grouped the different infrastructure factors in only five groups: *customs clearance, electricity, water, telecommunications and ICT,* and *transportation*. From this figure the high influence of *electricity* factors become even clearer. When we include the *provision of electricity* and *use of generators* or *power infrastructure* into a single group, the resulting block of electricity factors can explain more than half of average log productivity in Uganda, Ethiopia, Zambia, Eritrea, Swaziland, and Botswana. The water group is relatively important in Tanzania, Kenya, and Egypt. The customs clearance group gains importance in those countries with a more patent export orientation, such as Mauritius, Botswana, and Namibia. Finally, as has been signaled, the transportation subgroup explains more than half of the whole infrastructure impact on average log productivity in Senegal and Madagascar.

[FIGURES 6.25 ABOUT HERE]

Figure 6.26 reports the absolute percentage contribution of infrastructure by key factors via simulations. The results are fully consistent with the ones provided by figure 6.24. The relative weights of the electricity factors dominate in more than half the countries, and the water and telecommunications and ICT subgroups tend to play a secondary role in explaining average productivity when compared to electricity. The main difference with respect to figure 6.24 is the lower relative weight of the customs clearance group. Once again, it should be pointed out that the information provided by the simulations complements the results from the evaluation of the sample average of log productivity. In this case, we are talking about a cumulative effect, all other things being equal, since we evaluate the change in the average productivity when one of the INFs changes.

[FIGURES 6.26 ABOUT HERE]

The summary of results is complemented by the analysis of allocative efficiency. Figures 6.27 and 6.28 show that the impact of infrastructure on allocative efficiency is equally

distributed among the different infrastructure factors. The impact of water is, in this case, larger than in the case of average productivity, while the impact of energy provision is considerably less—gaining relative importance with the use of own generators. The positive effect of the use of own generators on allocative efficiency indicates that those firms that accumulate a larger proportion of market sales are also the firms that use their own generators. The same holds for the use of IC technologies and the use of own-water infrastructure. The customs clearance group has important implications for the allocative efficiency of Namibia, Mauritania, and Botswana. Finally, the quality of transport services plays a secondary role in explaining the behavior of allocative efficiency in the different countries included in our sample.

[FIGURES 6.27 ABOUT HERE]

Figure 6.28 organizes the different subgroups of infrastructure factors into five key groups. From this figure, the important contribution of the electricity subgroup becomes even clearer. Transportation explains more than 50 percent of the allocative efficiency in logs of Morocco. Once again, the relative importance of the water, telecommunications, and ICT subgroups is lower when compared to the contribution of electricity and customs clearance.

[FIGURES 6.28 ABOUT HERE]

7. Conclusions

For Africa's awaited growth resurgence to occur, a broad range of factors—political, institutional, and economic—must be improved. The World Bank's landmark Africa Competitiveness Reports (2004 and 2007) focus on problems that inhibit economic growth. It is agreed that improving Africa's infrastructure is a crucial step toward penetrating international markets and meeting the goals of continuous growth and poverty reduction.

Infrastructure quality has a pervasive influence on all areas of an economy. Low-quality infrastructure and limited transport and trade services increase logistical and transaction costs, rendering otherwise competitive products uncompetitive, as well as limiting rural production and people's access to markets—with adverse effects on economic activity and poverty. A large number of empirical studies illustrate the impact of infrastructure on economic performance. All suggest that Africa's infrastructure gap is an important growth bottleneck, with a negative impact on productivity and the overall competitiveness of the region. Using the methodology of Escribano and Guasch (2005, 2008) and Escribano et al. (2008), several studies have found empirical evidence—in cases such as Brazil, Chile, Costa Rica, Mexico, Turkey, and several Southeast Asian countries—that improvements in investment climate conditions in general,

and in infrastructure quality in particular, may lead to important gains in productivity and in other economic performance measures: employment, real wages, exporting activities, and inflows of foreign direct investment (FDI).

Approach and methods

This paper provided a systematic, empirical assessment of the impact of infrastructure quality on the TFP of African manufacturing firms. We applied microeconometric techniques to investment climate surveys of 26 African countries to gauge the impact of infrastructure quality on TFP.

For each country we estimated, by regression techniques, the impact of infrastructure quality based on 10 different productivity measures and showed that the results were robust once we controlled for other observable fixed effects (red tape, corruption and crime, finance, innovation and labor skills, and so on) obtained from the investment climate surveys (see Escribano and Guasch, 2005, 2008).

We pooled data from the investment climate surveys only for the few African countries for which we did not have sufficient observations for estimation purposes. Otherwise, we performed a country-by-country estimation to reveal firm and industry information by country. After pooling the data from several countries, the econometric results were then suitably disaggregated following the method of Olley and Pakes (1996) (Escribano et al., 2008), which allowed us to make country-specific evaluations of the impact of investment-climate quality on aggregate TFP, average TFP, and allocative efficiency.

We ranked the African countries in the study according to several aggregate indices: per capita income, ease of doing business, firm perceptions of growth bottlenecks, and the recent concept of *demeaned productivity (demeaned TFP)*, which overcame the problem of comparing apples and oranges when doing TFP cross-country comparisons (Escribano et al., 2008). We found the concept of demeaned productivity very useful because it is highly correlated with per capita income, ease of doing business indices, firm's perceptions of growth bottlenecks, and the results of the Africa Competitiveness Reports. Furthermore, the information obtained from the investment-climate determinants of demeaned TFP provided a much deeper insight into the firm-level investment-climate infrastructure elements that are constraining productivity growth in African countries.

We distinguished two clear blocks of countries in Africa.

The first block comprised countries with faster, steadier growth rates. These are mainly in the south, including Mauritius, Swaziland, South Africa, Botswana, Namibia, and Lesotho. The block also included Algeria, Morocco, and Egypt from the north, and Cape Verde and Cameroon

from Central Africa. In southern Africa Botswana, Namibia, and Swaziland, were pooled for estimation purposes.

In the second block were Mauritania, Senegal, Benin, Mali, Niger, and Burkina Faso in the central-west; and Uganda, Kenya, Zambia, Tanzania, Malawi, Burundi, Madagascar, Ethiopia, and Eritrea in the central-east. These countries have experienced lower and more irregular growth rates, with periods of both positive increase and persistent decrease in per capita income. Pooled for estimation purposes were the West African states (Burkina Faso, Cameroon, Mauritania, and Niger) and Eritrea and Ethiopia.

Out of the 26 African countries analyzed, Mauritius was, in 1950, the country with the highest per capita income (measured in terms of per capita gross domestic product, GDP), followed closely by South Africa, and, by a larger gap, Namibia and Algeria. But the per capita income levels in 2003 were somewhat different; Mauritius was still ranked first, followed by Swaziland, South Africa, and Botswana—and, by a wider gap—Algeria, Cape Verde, Egypt, and Morocco. Mauritius and Botswana experienced the highest sustained per capita income growth during recent years. Lesotho's rate is the median, splitting the study into two blocks.

To better understand the convergence or divergence of trends, we plotted the per capita income of each African country relative to the per capita income of the United States. Convergence was observed only in Mauritius, Swaziland, and Botswana. For all other study countries, including South Africa, per capita income was found to be diverging from the United States, while, in a few (Egypt, Morocco, and Cape Verde) the ratio was stable. While persistently positive GDP growth allowed Mauritius's per capita income to reach 45 percent of the United States' in 2003, this was clearly the exception (together with Swaziland and Botswana). For the rest of the countries, including South Africa, relative per capita income was much lower in 2003 than in 1960 (indicating a divergence). In fact, the 2003 per capita income of several countries was no larger than 5 percent of the per capita income of the United States. As expected, labor productivity was the main factor explaining this divergence, given that labor force participation has a steady influence. Since total factor productivity (TFP) is usually a key factor explaining the evolution of labor productivity, in this paper we used investment climate surveys to identify the main infrastructure-related TFP bottlenecks in Africa.

The per capita income rankings were correlated with the rankings obtained from the World Bank's 2007 *Doing Business* report. In 2007 Mauritius, Swaziland, South Africa, Botswana, and Namibia ranked 32nd, 76th, 29th, 48th, and 42nd in the world based on the ease-of-doing-business indicators. This index considers questions such as the number of days required to start a business and the ease of dealing with licenses, registering a property, trading across borders, employing workers, and so on. Other 2007 rankings include 83rd for Kenya, 97th for Ethiopia, 165th for Egypt, and 170th for Eritrea.

We showed the percentage of firms that *perceived* telecommunications, electricity, customs clearance, and transport as major obstacles to their economic performance. Only in Benin, Kenya, and Zambia did more than 50 percent of firms identify telecommunications as a severe obstacle. Meanwhile, the quality of electricity provision is a major problem for more than 50 percent of firms in more than half of the countries in our sample. In Burundi, Cameroon, Benin, Burkina Faso, and Cape Verde, the percentage of firms considering electricity as a severe or very severe obstacle exceeded 80 percent; on the other hand, only 20 percent of firms in Morocco, South Africa, Botswana, and Namibia considered electricity a severe obstacle. Customs clearance was considered an acute problem in Benin, Kenya, Madagascar, Senegal, and Algeria. Finally, transportation was considered a severe obstacle by more than 70 percent of firms in Burkina Faso and Benin.

The World Bank's 2007 Africa Competitiveness Report evaluated a wide range of factors related to economic activity, with infrastructure among them. Once again there were clearly different performance levels across the two blocks of countries. While in Namibia, South Africa, Botswana, Egypt, and Morocco, the quality of infrastructure exceeded the approval level, in the remaining countries this quality was rated low in most cases. The same held for the disaggregated results, including the number of telephone lines and the quality of ports, air transport, and electricity supply.

The difference between the two blocks becomes even more apparent when looking at the cross-plots between GDP per capita relative to the United States and firms' perceptions. A preliminary analysis of the cross-plots suggests two points: first, that there is an intuitive and negative relation between income level and infrastructure constraints; and, second, that the division of the two blocks of countries remains intact, showing now the largest dispersion in the constraint perceptions for the lowest per capita income group.

Findings

Among the countries of the high-income-growth block, infrastructure has a low impact on TFP (see panel B of figures 5.5 and 5.6 and panel A of figure 6.24). Red, tape, corruption, and crime dominate over infrastructure in countries such as Mauritius, Egypt, and South Africa (figure 5.5, panel B). Infrastructure quality has a high impact on TFP in the countries of the low-income-growth block (see panel B of figures 5.5 and 5.6 and panel A of figure 6.24), but the impact is very negative (see panel B of figures 5.3 and 5.4), identifying important bottlenecks for TFP growth.

We found much heterogeneity among individual infrastructure factors affecting countries in both the high- and low-growth blocks (see figure 6.26). Among related factors that most influence the average productivity TFP of African firms are:

- Poor-quality *electricity* provision, which affects mainly poor countries, such as Eritrea, Ethiopia, Mali, Senegal, Uganda, Zambia, and Kenya. It also affects countries that are growing faster, in relative terms, such as Botswana, Namibia, and Swaziland.
- Problems dealing with *customs* during importing or exporting affects mainly fast-growing countries, such as Mauritius, Morocco, and Swaziland. But low quality of customs also affects slow-growing countries, such as Niger, Mauritania, Cameroon, Malawi, Burkina Faso, and others.
- Losses from *transport interruptions* affect mainly slower-growing countries, such as Madagascar, Kenya, Tanzania, and Senegal.
- *Water outages* affect mainly slower-growing countries, such as Tanzania, Kenya, Burkina Faso, Mauritania, Niger, and Mali. But it also affects some of the faster-growing countries, such as Egypt.

Of the infrastructure determinants that most influence the *allocative efficiency* of African firms there is also some heterogeneity across countries.

- Poor-quality *electricity* provision affects the allocative efficiency of mainly poor countries, such as Zambia, Mali, Uganda, Eritrea, and Kenya.
- Problems dealing with *customs* while importing or exporting affects mainly slow-growing countries, such as Mauritania, Niger, and Cameroon. But it also affects the allocation efficiency of countries that are growing fast, such as Morocco, Namibia, and Mauritius.
- *Transport services* affects the allocative efficiency of mainly slower-growing countries, such as Madagascar, Senegal, and Tanzania.
- *Water provision* affects the allocative efficiency of mainly slower-growing countries, such as Tanzania, Kenya, and Mali.

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Appendix: Tables and figures

Table A.1 General information on firms and industries and on production function (PF) variables

General information at firm level	Industrial classification	(a) Food and beverages; (b) textiles and apparels; (c) chemicals, rubber, and plastics; (d) paper, printing, and publishing; (e) machinery and equipment/metallic products; (f) wood and furniture; (g) nonmetallic products; and (h) other manufacturing.
	Size classification	Small firms: less than 20 employees; medium firms in between 20 and 99 employees; large firms more than 99 employees.
	Country/Region classification	1) Algeria: Region A, Region B, Region C, Region D 2) Benin: South (coastal), rest of country (rainforest) 3) Botswana: Francistown, Gaborone 4) Burkina Faso: Ouagadougou, rest of country 5) Burundi: Bujumbura 6) Cameroon: Bafoussam, Douala, Yaounde 7) Cape Verde: Mindelo, Praia 8) Eritrea: Eritrea 9) Ethiopia: Addis Ababa, Awasa, Bahir Dar, Dire Adwa, Mekele, Nazareth, Gondar, Adigrat, Harar, Adwa, rest of country 10) Kenya: Nairobi, rest of country 11) Madagascar: Antananarivo, rest of country 12) Malawi: Blantyre, Lilongwe, rest of country 13) Mali: Bamako, rest of country 14) Mauritania: Noauadhibou, Nouakchott 15) Mauritius: Port Louis, Beau Bassin, Vacoas Phoenix, Curepipe, Quatre Bornes, other 16) Morocco: Settat, Nador, Casablanca, Rabat, Fes, Tanger 17) Namibia: Walvis Bay, Windhoek 18) Niger: Maradi, Niamey 19) Senegal: Dakar, rest of country 20) South Africa: Gauteng, Kwazulu, Natal, Western Cape, Eastern Cape 21) Swaziland: Matsapha, Manzini, Mbabane 22) Tanzania: Dar es Salaam, Kilimanjaro, Tanga/Arusha, Lake Victoria, South, Zanzibar; 23) Uganda: Central, North East, South West 24) Lesotho: Maseru, rest of country 25) Egypt: Cairo, Suez Channel, Qualyubia, Menoufiya, Alexandria, Nile Delta, Sharkiya, Lower Egypt 26) Zambia: Lusaka, Ndola, Kitwe, rest of country
PF variables (productivity)	Sales	Used as the measure of output for the PF estimation. Sales are defined as total annual sales. The series are deflated by using the consumer price index (CPI), base 2000.
	Employment	Total number of permanent (full-time) and temporal (full-time) workers.
	Total hours worked per year	Total number of employees multiplied by the average hours worked per year.
	Materials	Total costs of intermediate and raw materials used in production (excluding fuel). The series are deflated by using the CPI deflator, base 2000.
	Capital stock	Net book value of machinery and equipment (NBVC); for those countries which the net book value is not available it is replaced by the replacement cost of machinery and equipment. The series are deflated by using the CPI deflator, base 2000.
	User cost of capital	The user cost of capital is defined in terms of the opportunity cost of using capital; it is defined as the 15 percent of the value of the capital stock.
	Labor cost	Total expenditures on personnel, deflated by using the CPI deflator, base 2000.

Source: IC data.

Note: All figures are in U.S. dollars.

Table A.2.1 Definition of investment climate (IC) variables; infrastructure

Name of the variable	Description of the variable
Days to clear customs to import	Average number of days to clear customs when importing.
Longest number of days to clear customs to import	Longest number of days to clear customs when importing.
Days to clear customs to export	Average number of days to clear customs when exporting directly.
Longest number of days to clear customs to export	Longest number of days to clear customs when exporting directly.
Cost to clear customs to export	Total cost to clear customs for a typical consignment as a percentage of the consignment value (including payments to clearing agents, storage fees, container handling fees, and gifts or informal payments to customs officials).
Inspections in customs	Percentage of establishment's exports that were physically inspected during last financial year (LFY).
Shipment losses in customs to export	Percentage of the consignment value of the products shipped to be exported that was lost while in transit because of breakage or spoilage.
Dummy for profit from export facilities	Dummy taking value 1 if the plants enjoy a export facility such as customs duty drawback, duty suspension on imported inputs, profit tax exemption, and so on.
Cost of exports	Percent of the value of export earnings was transport costs.
Dummy for public mechanism to cover risks in exports	Dummy taking value 1 if the firm has a public mechanism to cover risk of nonpayment of exported products.
Dummy for outside clearing agent for imports	Dummy variable taking value 1 if the firms uses an agent to facilitate customs clearance for imports.
Average number of days to clear an outgoing container through port	Average time of clearing an outgoing container through a port clear (including preshipment inspection).
Cost to clear an outgoing container through port	Average cost of clearing an outgoing container through a port clear (including preshipment inspection).
Average number of days to clear an incoming container through port	Average time of clearing an incoming container through a port clear (including preshipment inspection).
Cost to clear an incoming container through port	Average cost of clearing an incoming container through a port clear (including preshipment inspection).
Dummy for own power infrastructure	Dummy taking value 1 if the firm provides its own power infrastructure, excluding generators.
Dummy for own generator	Dummy variable taking value 1 if the firm has its own power generator.
Electricity from own generator	Percentage of the electricity used by the plant provided by a own generator.
Cost of electricity from generator	Estimated annual cost of generator fuel as percentage of annual sales.
Cost of electricity from public grid	Average cost per kilowatt-hour (KwH) when using power from the public grid.
Dummy for equipment damaged by power fluctuations	Dummy taking value 1 if any machine or equipment was damaged by power fluctuations.
Equipment damaged by power fluctuations	Value of the losses of machinery and equipment damaged by power fluctuations as a percentage of the net book value of machinery and equipment (NBVC).
Power outages	Total number of power outages suffered by the plant in LFY.
Average duration of power outages	Average duration of power outages suffered in hours, conditional on the pant reports having power outages.
Power fluctuations	Total number of power fluctuations suffered by the plant in LFY.
Average duration of power fluctuations	Average duration of power fluctuations suffered in hours, conditional on the plant reports having power fluctuations.
Sales lost due to power outages	Losses due to power outages as a percentage of total annual sales, conditional on the plant reports having power outages.
Water outages	Total number of water outages suffered by the plant in LFY.
Average duration of water outages	Average duration of water outages suffered in hours, conditional on the plant reports having water outages.
Sales lost due to water outages	Losses due to water outages as a percentage of total annual sales, conditional on the plant reports having power outages.
Dummy for own well or water infrastructure	Dummy taking value 1 if the plant has its own or shared borehole or well, or builds its own water infrastructure.
Water from own well or water infrastructure	Percentage of firm's water supply from its own or shared well.
Cost of water from own well	Total annual cost of self-provided water as a percentage of total annual sales.
Cost of water from public system	Unit cost of using water from the public water system.
Phone outages	Total number of phone outages suffered by the plant in LFY.
Average duration of phone outages	Average duration of phone outages suffered in hours, conditional on the plant reports having water outages.
Losses due to phone outages	Losses due to phone outages as a percentage of total annual sales, conditional on the plant reports having power outages.
Transport failures	Total number of transport failures suffered by the plant in LFY.
Average duration of transport failures	Average duration of transport failures suffered in hours, conditional on the plant reports having water outages.
Sales lost due to transport failures	Losses due to transport failures as a percentage of total annual sales, conditional on the plant reports having power outages.

Source: IC data.

Table A.2.1 Definition of IC variables; infrastructure (cont.)

Name of the variable	Description of the variable
Average duration of transport	Time in hours that it takes to ship the inputs transported by road from the point of origin to the establishment.
Public postal service interruptions	Total number of public postal service interruptions suffered by the plant in LFY.
Average duration of public postal service interruptions	Average duration of public postal service interruptions suffered in hours, conditional on the plant reports having water outages.
Sales lost due to public postal service interruptions	Losses due to public postal service interruptions as a percentage of total annual sales, conditional on the plant reports having power outages.
Dummy for own roads	Dummy taking value 1 if the firm provides its own roads.
Dummy for own transportation for workers	Dummy taking value 1 if the firm provides its transportation for workers.
Dummy for own waste disposal	Dummy taking value 1 if the firm provides its own waste disposal.
Dummy for contract with transportation company	Dummy taking value 1 if the firm arranges transport services for the delivery of finished products, or raw materials by direct contract with transportation company.
Dummy for own transportation	Dummy taking value 1 if the firm arranges transport services for the delivery of finished products, or raw materials with its own transportation.
Products with own transport	Percentage of products delivered with firm's own transport.
Transport delay, outgoing domestic merchandise	Percentage of times that transport services are late in picking up sales for domestic markets at the plant for delivery.
Transport delay, outgoing export merchandise	Percentage of times that transport services are late in picking up sales for exports at the plant for delivery.
Transport delay, incoming domestic merchandise	Percentage of times that transport services are late in dropping off supplies from domestic sources at the plant for delivery.
Transport delay, incoming export merchandise	Percentage of times that transport services are late in dropping off direct imports at the plant for delivery.
Shipment losses, domestic	Percentage of the consignment value of the products shipped for domestic transportation lost while in transit because of theft, breakage, or spoilage.
Shipment losses, exports	Percentage of the consignment value of the products shipped for international transportation lost while in transit because of theft, breakage, or spoilage.
Dummy for e-mail	Dummy variable taking value 1 if the plant mainly uses e-mail to communicate with clients and suppliers.
Dummy for Web page	Dummy variable taking value 1 if the plant uses its own Web page to communicate with clients and suppliers.
Wait for phone connection	Number of days waiting to obtain a phone connection.
Dummy for gifts to obtain a phone connection	Gifts expected or requested to obtain a phone supply.
Wait for electric supply	Number of days waiting to obtain an electricity supply.
Dummy for gifts to obtain a electric supply	Gifts expected or requested to obtain an electrical connection.
Wait for a water supply	Number of days waiting for a water supply.
Dummy for gifts to obtain a water supply	Gifts expected or requested to obtain a water supply.
Wait for an import license	Number of days waiting for an import license.
Dummy for gifts to obtain an import license	Gifts expected or requested to obtain an import license.
Low quality supplies	Percentage of domestic inputs/supplies that are of lower than agreed-upon quality.
Sales lost due to delivery delays, domestic	Percentage of domestic sales lost due to delivery delays from suppliers in LFY.
Sales lost due to delivery delays, imports	Percentage of exports lost due to delivery delays from suppliers in LFY.
Transport delays in domestic sales	Percentage of domestic sales lost due to delays in transportation services in LFY.
Transport delays in international sales	Percentage of exports lost due to delays in transportation services in LFY.
Illegal payments to obtain public utilities	Amount (as a percentage of total annual sales) spent by a typical establishment in "unofficial payments" for public utilities (that is, power, water and sewage, and telephone).
Days of inventory of main supply	Average number of days (measured in production days) that the main input is available on stock.
Days of inventory of finished goods	Average number of days (measured in production days) that the main output is available on stock.

Source: IC data.

Table A.2.2 Definition of IC variables; red tape, corruption, and crime

Name of the variable	Description of the variable
Manager's time spent in bureaucratic issues	In typical week percentage of manager's time spent dealing with bureaucratic issues.
Payments to deal with bureaucratic issues	Total payments as a percentage of total annual sales to "speed up" bureaucratic issues.
Illegal payments to obtain licenses	Amount (as a percentage of total annual sales) spent by a typical establishment in "unofficial payments" for licenses from government institutions, for example, a city council.
Illegal payments to tax administration	Amount (as a percentage of total annual sales) spent by a typical establishment in "unofficial payments" to tax administration.
Wait for a construction permit	Days waiting to obtain a construction permit.
Dummy for gifts to obtain a construction permit	Gifts expected or requested to obtain a construction permit.
Wait for an operating license	Days waiting to obtain a main operating license.
Gifts to obtain an operating license	Gifts expected or requested to obtain a main operating license.
Sales declared to taxes	Percentage of total annual sales that a typical firm operating in plant's sector reports for tax purposes.
Workforce declared to taxes	Percentage of total workforce that a typical firm operating in plant's sector reports for tax purposes.
Days in inspections	Total number of inspections from regulatory agencies received by the plant in LFY.
Dummy for gifts in inspections	Dummy taking value 1 if any informal gift or payment were requested during inspections from regulatory agencies.
Dummy for lawyer/consultant to help deal with permissions	Dummy taking value 1 if the plant uses/used a lawyer and/or consultant to help obtaining all the permissions and licenses needed to operate/enter the market.
Payments to obtain a contract with the government	Payments to obtain a contract with the government as a percentage of contract value.
Dummy for law-influencing firm	Dummy taking value 1 if the firm seeks to influence local or national laws.
Overdue payments to private customers	Percentage of total sales to private enterprises that involved overdue payments in LFY.
Overdue payments to state-owned enterprises (SOEs)	Percentage of total sales to government agencies or SOEs that involved overdue payments in LFY.
Weeks to resolve a case of overdue payment	Percentage of overdue payments that required the action of a court to be solved.
Overdue payments in courts	Percentage of total sales to private enterprises that involved overdue payments that were resolved in courts in LFY.
Weeks to resolve an overdue payment in courts	Weeks that it takes to resolve a typical case of overdue payment in courts
Security expenses	Security expenses as a percentage of annual total sales.
Dummy for security expenses	Dummy taking value 1 if the plant has security expenses.
Illegal payments in protection	Cost in illegal payments to avoid violence, for example to criminal organizations.
Dummy for payments in protection	Dummy taking value 1 if the plant has cost in illegal payments to avoid violence.
Cost to avoid pilferage from workers	Cost in illegal payments to reduce pilferage by workers.
Dummy for cost to avoid pilferage from workers	Dummy taking value 1 if the plant has costs to reduce pilferage by workers.
Crime losses	Crime losses as a percentage of annual total sales in LFY.
Dummy for crime losses	Dummy taking value 1 if the plant has experienced losses due to criminal attempts in LFY.
Crimes reported to police	Percentage of criminal attempts reported to the police.
Crimes solved by police	Percentage of criminal attempts solved by the police.
Days of production lost due to civil unrest	Total number of production days lost due to civil unrest during LFY.
Days of production lost due to absenteeism	Total number of production days lost due to employees absenteeism during LFY.
Dummy for tax exemption	Dummy variable that takes value 1 if the labor regulation has affected plant's employment decisions.
Dummy for lawsuit in the last 3 years	Dummy taking value 1 if the plant had any lawsuit during the last 3 years
Dummy for "gifts" for credit	Dummy if the firm had to offer a gift or an informal payment to get a credit.
Dummy for interventionist labor regulation	Dummy taking value 1 if plant's decisions on hiring and/or firing workers have been influenced by labor regulations.
Total days spent with licenses	Total number of days that were spent dealing with licenses LFY.
Dummy for accountant to accomplish taxes	Dummy if the firm uses an accountant or consultant to accomplish taxes.
Dummy for gifts to tax inspectors	Dummy if the firm had to offer a gift or an informal payment to tax inspectors.
Gifts to tax inspectors	Amount (as a percentage of total annual sales) paid to tax inspectors in gifts and/or irregular payments.
Dummy for labor conflicts	Dummy taking value 1 if the firm had any conflict with employees during LFY.
Average time to hire a skilled worker	Average days that it takes to hire a skilled production worker.
Dummy for conflicts with suppliers	Dummy taking value 1 if the firm had any conflict with suppliers during LFY.
Dummy for conflicts with clients	Dummy taking value 1 if the firm had any conflict with clients during LFY.
Cost of entry	Cost of entry to the market in terms of licenses and permissions needed.
Dummy for consultant to help deal with permissions	Dummy taking value 1 if the firm uses consultants and/or lawyers to help deal with licenses and permissions.

Source: IC data.

Table A.2.3 Definition of IC variables; finance and corporate governance

Name of the variable	Description of the variable
Dummy for trade chamber	Dummy taking value 1 if the firm belongs to a trade chamber or association.
Dummy for credit line	Dummy that takes value 1 if the firm has access to a credit line or overdraft facility.
Credit unused	Percentage of the overdraft that is not being used currently.
Dummy for loan	Dummy that takes value 1 if the firm has access to a loan line.
Dummy for loan with collateral	Dummy that takes value 1 if the firm has access to a loan line with collateral (conditional on having a loan line).
Value of the collateral	Value of the collateral as a percentage of the loan value (conditional on having a loan with collateral).
Interest rate of the loan	The interest rate applied to the last loan.
Dummy for short-term loan	Duration of the loan in years.
Borrowings in foreign currency	Percentage of firm's borrows denominated in a foreign currency.
Dummy for external auditory	Dummy that takes value 1 if the firm has its annual statements externally audited.
Owner of the lands	Percentage of the lands in which the plant operates owned by the firm.
Owner of the buildings	Percentage of the buildings in which the plant operates owned by the firm.
Dummy for owner of the buildings	Dummy taking value 1 if the almost all the buildings in which the plant operates are owned by the firm.
Dummy for owner of the buildings and lands	Dummy taking value 1 if the almost all the lands in which the plant operates are owned by the firm.
Largest shareholder	Percentage of firm's capital owned by the largest shareholder.
Working capital financed by internal funds	Percentage of firm's working capital financed by internal funds.
Working capital financed by commercial banks	Percentage of firm's working capital financed by funds from private domestic banks.
Working capital financed by foreign commercial banks	Percentage of firm's working capital financed by funds from foreign banks.
Working capital financed by leasing	Percentage of firm's working capital financed by leasing.
Working capital financed by state services	Percentage of firm's working capital financed by funds from state services (for example, Brazilian Development Bank, BNDES; Mexican labor and income generation program, PROGER; and so on).
Working capital financed by supplier or customer credit	Percentage of firm's working capital financed by trade credit (supplier or customer credit).
Working capital financed by credit cards	Percentage of firm's working capital financed by credit card.
Working capital financed by equity	Percentage of firm's working capital financed by equity, sale of stock.
Working capital financed by family/friends	Percentage of firm's working capital financed by funds from family or friends.
Working capital financed by informal sources	Percentage of firm's working capital financed by funds from informal sources (for example, money lender).
Working capital financed by other funds	Percentage of firm's working capital financed by other funds.
New investments financed by internal funds	Percentage of new investments in new lands, buildings, or machinery financed by internal funds.
New investments financed by commercial banks	Percentage of new investments in new lands, buildings, or machinery financed by funds from private domestic banks.
New investments financed by foreign commercial banks	Percentage of new investments in new lands, buildings, or machinery financed by funds from foreign banks.
New investments financed by leasing	Percentage of new investments in new lands, buildings, or machinery financed by leasing.
New investments financed by state services	Percentage of new investments in new lands, buildings, or machinery financed by funds from state services (for example, BNDES, PROGER, and so on).
New investments financed by supplier or customer credit	Percentage of new investments in new lands, buildings, or machinery financed by trade credit (supplier or customer credit).
New investments financed by credit cards	Percentage of new investments in new lands, buildings, or machinery financed by credit card.
New investments financed by equity	Percentage of new investments in new lands, buildings, or machinery financed by equity, sale of stock.
New investments financed by family/friends	Percentage of new investments in new lands, buildings, or machinery financed by funds from family or friends.
New investments financed by informal sources	Percentage of new investments in new lands, buildings, or machinery financed by funds from informal sources (for example money lender).
New investments financed by other funds	Percentage of new investments in new lands, buildings, or machinery financed by other funds.
Share of net profits reinvested	Share of net profits reinvested in the firm in the LFY.
Sales bought on credit	Percentage of establishment's inputs that were purchased on credit in LFY.
Dummy for inputs bought on credit	Days that it takes for the establishment to pay off the supply credit.
Inputs bought on credit	Percentage of establishment's total sales that were bought on credit during LFY.

Source: IC data.

Table A.2.3 Definition of IC variables; finance and corporate governance (cont.)

Name of the variable	Description of the variable
Time to pay off the credit for inputs	Average days that it takes to pay off the credits.
Inputs bought on credit with delayed payment	Share of inputs bought on credit.
Wait to clear a check	Total number of days needed on average to clear a check from the establishment's financial institution.
Charges to clear a check	Average fee charged for a check.
Wait to clear a domestic currency wire	Total number of days needed on average to clear a domestic currency wire from the establishment's financial institution.
Charges to clear a domestic currency wire	Average fee charged for a domestic currency wire.
Wait to clear a foreign currency wire	Total number of days needed on average to clear a foreign currency wire from the establishment's financial institution.
Charges to clear a foreign currency wire	Average fee charged for a foreign currency wire.
Wait to clear a letter of credit	Total number of days needed on average to clear a letter of credit from the establishment's financial institution.
Charge to clear a letter of credit	Average fee charged for a letter of credit.
Delay of payments of domestic clients	Total number of days needed on average to clear a payment from a domestic customer.
Charges to get payments from domestic clients	Average fee charged to clear a payment of a domestic customer.
Delay of payments of foreign clients	Total number of days needed on average to clear a payment from a foreign customer.
Charges to get payments from foreign clients	Average fee charged to clear a payment of a foreign customer.
Dummy for current or saving account	Dummy taking value 1 if the firm has a checking or saving account.
Dummy for foreign current or saving account	Dummy taking value 1 if the firm has a foreign checking or saving account.
Dummy for accountant	Dummy taking value 1 if the firm uses an accountant to finish annual statements.

Source: IC data.

Table A.2.4 Definition of IC variables; quality, innovation, and labor skills

Name of the variable	Description of the variable
Dummy for foreign technology	Dummy taking value 1 if the plant uses technology licensed from a foreign-owned company.
Dummy for International Organization for Standardization (ISO) quality certification	Dummy taking value 1 if the firm has any kind of quality certification.
Sales with warranty	Percentage of sales bought with warranty.
Dummy for new product	Dummy taking value 1 if the firm developed a major new product line during LFY.
Dummy for product improvement	Dummy taking value 1 if the firm improved an existing product line during LFY.
Dummy for discontinued product line	Dummy taking value 1 if the firm discontinued at least one product line during LFY.
Dummy for equipment improvement	Dummy taking value 1 if the firm improved the equipment during LFY.
Dummy for R&D	Dummy taking value 1 if the firm had expenses in R&D during LFY.
R&D expenditures	R&D expenditures as a percentage of annual total sales.
Workers engaged in design/R&D	Percentage of workers in staff engaged in R&D and design tasks.
Dummy for subcontracted R&D	Dummy taking value 1 if the firm subcontracted R&D activities during LFY.
Royalties expenditures	Total expenses in royalties as a percentage of total annual sales.
Dummy for new technology	Dummy taking value 1 if the firm introduced a new technology that substantially changed the way that the main product is produced.
Dummy for joint venture	Dummy taking value 1 if the firm agreed a new joint venture with foreign partner during LFY.
Dummy for new license agreement	Dummy taking value 1 if the firm obtained a new license agreement during LFY.
Dummy for outsourcing	Dummy taking value 1 if the firm outsourced a major production activity that was previously conducted in-house during LFY.
Dummy for in-house production	Dummy taking value 1 if the firm brought in-house a major production activity that was previously outsourced during LFY.
Dummy for new plant	Dummy taking value 1 if the firm opened a new plant during LFY.
Dummy for closed plant	Dummy taking value 1 if the firm closed an existing plant during LFY.
Staff—management	Percentage of management in staff.
Staff—professional workers	Percentage of professional production workers in staff.
Staff—skilled workers	Percentage of skilled production workers in staff.
Staff—unskilled workers	Percentage of unskilled production workers in staff.
Staff—nonproduction workers	Percentage of nonproduction workers in staff.
Staff—foreign nationals	Percentage of foreign national workers in staff.
Average education of staff	Average number of years of education of staff.
Average tenure of staff	Average number of years of experience of staff.
Average age of staff	Average age of staff.
Dummy for training	Dummy taking value 1 if the firm provides formal (either internal or external) training to its employees.
Training to skilled workers	Percentage of skilled workers receiving formal (either internal or external) training.
Training to unskilled workers	Percentage of unskilled workers receiving formal (either internal or external) training.
Training to production workers	Percentage of production workers receiving formal (either internal or external) training.
Training to nonproduction	Percentage of nonproduction workers receiving formal (either internal or external) training.
Weeks of training for skilled workers	Weeks of training received by skilled workers.
Weeks of training for unskilled workers	Weeks of training received by unskilled workers.
Workforce with computer	Percentage of workforce using a computer at job.
University staff	Percentage of staff with at least 1 year of university education.
Dummy for university staff	Percentage of staff that regularly uses computer at job.
Manager education	Dummy taking value 1 if the manager of the establishment has a bachelor degree or higher education level.
Manager's experience	Years of experience of the manager in the same industry before joining the establishment.

Source: IC data.

Table A.2.5 Definition of variables; other control variables

Name of the variable	Description of the variable
Age	Age of the firm.
Dummy for incorporated company	Dummy that takes value 1 if the firm is an incorporated company.
Dummy for limited company	Dummy that takes value 1 if the firm is a limited company.
Dummy for SOE	Dummy variable that takes value 1 if the plant is a SOE.
Dummy for foreign direct investment (FDI)	Dummy that takes value 1 if any part of firm's capital is foreign.
Dummy for holdings	Dummy variable that takes value 1 if the firm has holdings or operations in other countries.
Share of the local market	Percentage of local market that is made up by the sales of the establishment.
Share of the national market	Percentage of national market that is made up by the sales of the establishment.
Dummy for direct exports	Dummy taking value 1 if the firm exports more than 10% of the total annual sales.
Share of exports	Share of exports over total annual sales.
Exporting experience	Number of years of exporting experience.
Dummy for direct imports	Dummy taking value 1 if the firm imports more than 10% of the total purchases of intermediate materials.
Share of imports	Share of imported inputs over total purchases of intermediate materials.
Number of competitors	Total number of competitors in the local market of the establishment's main product line.
Capacity utilization	Percentage of capacity utilized.
Trade union	Percentage of workforce unionized
Dummy for privatized firm	Dummy variable that takes value 1 if the firm was previously state-owned.
Dummy for industrial zone	Dummy variable that takes value 1 if the firm is located in an industrial zone.
Days of production lost due to strikes	Total number of production days lost due to strikes.
Dummy for small firm	Dummy taking value 1 if the firm has less than 20 employees.
Dummy for medium firm	Dummy taking value 1 if the firm has in between 20 and 100 employees.
Dummy for large firm	Dummy taking value 1 if the firm has more than 100 employees.
Workers infected by HIV	Percentage of workers infected by HIV/AIDS.
Dummy for negative impact of HIV	Dummy variable that takes value 1 if the HIV/AIDS epidemic has negatively affected the firm through absenteeism of workers or high staff turnover.
Cost in HIV-prevention programs	Medical expenses for staff (HIV/AIDS related) as percentage of total sales.

Source: IC data.

Table A.3 Summary of the investment climate assessment (ICA) surveys, sorted by geographical area

		Year of survey	Years of production function (PF) variables	Total number of observations[1]	Final number of observations available for regression analysis[2]
North Africa	Algeria	2002	2000–1	952	706
	Egypt	2004	2001–3	2,931	2,629
	Morocco	2003	2000–2	2,550	2,422
Economic Community of West African States (ECOWAS)	Senegal	2003	2000–2	783	535
	Benin	2004	2001–3	591	475
	Mali	2003	2000–2	462	309
	Cape Verde[3]	2006	2005	47	47
	Mauritania*	2006	2005	80	80
	Burkina Faso*	2006	2005	51	51
	Niger*	2005	2004	64	48
	Cameroon*	2006	2005	119	118
Horn of Africa	Ethiopia**	2002	1999–2001	1,281	1,142
	Eritrea**	2002	2000–1	237	179
East African Community (EAC)	Kenya	2003	2000–2	852	577
	Uganda	2003	2001–2	900	635
	Tanzania	2003	2000–2	828	561
	Burundi[3]	2006	2005	102	101
Southern African Development Community (SADC)	Malawi	2005	2004–5	320	288
	Madagascar	2005	2002–4	870	623
	Zambia	2002	1999–2001	564	417
	Lesotho[3]	2003	2000–2	225	79
	Botswana***	2006	2005	114	112
	Namibia***	2006	2005	106	104
	Swaziland***	2006	2005	70	69
Mauritius		2005	2002–4	636	417
South Africa		2003	2001–2	1,737	1,492

Source: Authors´ calculations; ICA data.

Note:

[1] Total number of observations is equal to the total number of firms surveyed multiplied by the total number of years.

[2] The observations available for regression analysis are the total number of observations minus the observations with any PF variable missing and/ or outlier after the cleaning process.

[3] Countries for which no regression analysis was conducted.

* Countries pooled for regression analysis: Mauritania, Burkina Faso, Niger, and Cameroon.

** Countries pooled for regression analysis: Ethiopia and Eritrea.

*** Countries pooled for regression analysis: Botswana, Namibia, and Swaziland.

Table B.1 Total number of observations available for the PF variables before and after cleaning missing values and outliers

Percentage over total number of observations in parentheses

	Northern Africa				Western Africa—Economic Community of West African States (ECOWAS)							Horn of Africa	
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI
Total number of observations	952	2,931	2,550	783	591	462	80	51	47	64	119	1281	237
a) Before cleaning													
Missing observations	605 (63.5)	1,543 (52.6)	95 (3.73)	513 (65.5)	199 (33.6)	211 (45.6)	1 (1.25)	1 (1.96)	0	49 (76.5)	2 (1.68)	150 (11.7)	171 (72.1)
of which:													
firms with one PF variable missing	419 (44.0)	1,009 (34.4)	29 (1.14)	189 (24.1)	146 (24.7)	39 (8.44)	0	1 (1.96)	0	11 (17.1)	1 (0.84)	33 (2.58)	88 (37.1)
firms with two PF variables missing	0	34 (1.16)	1 (0.04)	88 (11.2)	18 (3.05)	25 (5.41)	1 (1.25)	0	0	2 (3.13)	0 (0.00)	9 (0.70)	2 (0.84)
firms with three PF variables missing	0	319 (10.8)	2 (0.08)	57 (7.28)	8 (1.35)	18 (3.90)	0	0	0	25 (39.0)	0 (0.00)	7 (0.55)	30 (12.6)
firms with four PF variables missing	186 (19.5)	181 (6.18)	63 (2.47)	179 (22.8)	27 (4.57)	129 (27.9)	0	0	0	11 (17.1)	1 (0.84)	101 (7.88)	51 (21.5)
Outliers	62 (6.51)	131 (4.47)	103 (4.04)	29 (3.70)	42 (7.11)	10 (2.16)	0	0	0	1 (1.56)	0	83 (6.48)	10 (4.22)
of which:													
outliers in materials	24 (2.52)	78 (2.66)	69 (2.71)	23 (2.94)	31 (5.25)	5 (1.08)	0	0	0	0	0	83 (6.48)	4 (1.69)
outliers in labor cost	21 (2.21)	33 (1.13)	18 (0.71)	3 (0.38)	4 (0.68)	3 (0.65)	0	0	0	1 (1.56)	0	0	4 (1.69)
outliers in both materials and labor cost	17 (1.79)	20 (0.68)	16 (0.63)	3 (0.38)	7 (1.18)	2 (0.43)	0	0	0	0	0	0	2 (0.84)
Available observations after replacing (outliers and missing excluded)	316 (33.1)	1,317 (44.9)	2,352 (92.2)	253 (32.3)	364 (61.5)	242 (52.3)	79 (98.7)	50 (98.0)	47 (100.)	14 (21.8)	117 (98.3)	1,048 (81.8)	61 (25.7)
b) After cleaning													
Missing observations	198 (20.8)	225 (7.68)	71 (2.78)	179 (22.8)	42 (7.11)	129 (27.9)	0	0	0	11 (17.1)	1 (0.84)	101 (7.88)	51 (21.5)
of which:													
firms with one PF variable missing	12 (1.26)	9 (0.31)	8 (0.31)	0	9 (1.52)	0	0	0	0	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
firms with two PF variables missing	0	0	0	0	2 (0.34)	0	0	0	0	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
firms with three PF variables missing	0	34 (1.16)	0	0	1 (0.17)	0	0	0	0	0 (0.00)	0 (0.00)	0 (0.00)	0 (0.00)
firms with four PF variables missing	186 (19.5)	182 (6.21)	63 (2.47)	179 (22.8)	30 (5.08)	129 (27.9)	0	0	0	11 (17.1)	1 (0.84)	101 (7.88)	51 (21.5)
Outliers	60 (6.30)	82 (2.80)	65 (2.55)	69 (8.81)	77 (13.0)	24 (5.19)	0	0	0	5 (7.81)	0	38 (2.97)	7 (2.95)
of which:													
outliers in materials	16 (1.68)	46 (1.57)	35 (1.37)	48 (6.13)	58 (9.81)	22 (4.76)	0	0	0	4 (6.25)	0	38 (2.97)	2 (0.84)
outliers in labor cost	18 (1.89)	10 (0.34)	14 (0.55)	12 (1.53)	8 (1.35)	0 (0.00)	0	0	0	1 (1.56)	0	0 (0.00)	3 (1.27)
outliers in both materials and labor cost	26 (2.73)	26 (0.89)	16 (0.63)	9 (1.15)	11 (1.86)	2 (0.43)	0	0	0	0 (0.00)	0	0 (0.00)	2 (0.84)
Available observations after replacing (outliers and missing excluded)	706 (74.1)	2,629 (89.7)	2,422 (94.9)	535 (68.3)	475 (80.3)	309 (66.8)	80 (100)	51 (100.)	47 (100)	48 (75.0)	118 (99.1)	1,142 (89.1)	179 (75.5)

Source: IC data.

Note: The PF variables are: sales, materials, capital stock, and labor cost; the total number of hours worked per year are not included here. For the countries with panel data, the total number of observations is equal to the total number of firms surveyed, multiplied by the total number of years. For the countries with cross-sectional data the total number of observations is equal to the total number of firms surveyed. Outliers are defined as those observations with the ratio of materials to sales and/or labor cost to sales greater than 1. By useful observations we mean those observations available to run regression and to make statistical inference. Missing observations and/or outliers in sales, materials, or labor cost are therefore not initially considered useful available observations.

Table B.1 (cont.) Total number of observations available for the PF variables before and after cleaning missing values and outliers

Percentage over total number of observations in parentheses)

	Eastern Africa—East African Community (EAC excl. Burundi)			Southern Africa—Southern African Development Community (SADC incl. Burundi)								MUS	ZAF
	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Total number of observations	852	900	828	320	870	564	102	114	225	106	70	636	1737
							a) Before cleaning						
Missing observations	426 (50.0)	652 (72.4)	457 (55.1)	106 (33.1)	456 (52.4)	153 (27.1)	0 (0.00)	4 (3.51)	187 (83.1)	5 (4.72)	3 (4.28)	340 (53.4)	487 (28.0)
of which:													
firms with one PF variable missing	112 (13.1)	288 (32.0)	189 (22.8)	76 (23.7)	184 (21.1)	26 (4.61)	0	3 (2.63)	38 (16.8)	5 (4.72)	2 (2.85)	117 (18.4)	241 (13.8)
firms with two PF variables missing	48 (5.63)	40 (4.44)	75 (9.06)	8 (2.50)	62 (7.13)	0	0	0	7 (3.11)	0	1 (1.42)	37 (5.82)	37 (2.13)
firms with three PF variables missing	62 (7.28)	95 (10.5)	32 (3.86)	0 (0.00)	30 (3.45)	6 (1.06)	0	0	12 (5.33)	0	0	13 (2.04)	11 (0.63)
firms with four PF variables missing	204 (23.9)	229 (25.4)	161 (19.4)	22 (6.88)	180 (20.6)	121 (21.4)	0	1 (0.88)	130 (57.7)	0	0	173 (27.2)	198 (11.4)
Outliers	53 (6.22)	41 (4.56)	55 (6.64)	10 (3.13)	40 (4.60)	20 (3.55)	2 (1.96)	1 (0.88)	6 (2.67)	1 (0.94)	0	28 (4.40)	34 (1.96)
of which:													
outliers in materials	46 (5.40)	19 (2.11)	25 (3.02)	9 (2.81)	20 (2.30)	18 (3.19)	2 (1.96)	1 (0.88)	0 (0.00)	1 (0.94)	0	9 (1.42)	12 (0.69)
outliers in labor cost	4 (0.47)	16 (1.78)	19 (2.29)	1 (0.31)	17 (1.95)	2 (0.35)	0 (0.00)	0 (0.00)	5 (2.22)	0	0	14 (2.20)	14 (0.81)
outliers in both materials and labor cost	3 (0.35)	6 (0.67)	11 (1.33)	0 (0.00)	3 (0.34)	0 (0.00)	0 (0.00)	0 (0.00)	1 (0.44)	0	0	5 (0.79)	8 (0.46)
Available observations after replacing (outliers and missing excluded)	377 (44.2)	232 (25.7)	325 (39.2)	208 (65.0)	383 (44.0)	391 (69.3)	109 (106.)	100 (87.7)	37 (16.4)	100 (94.3)	67 (95.7)	271 (42.6)	1,229 (70.7)
							b) After cleaning						
Missing observations	205 (24.0)	234 (26.0)	164 (19.8)	22 (6.88)	181 (20.8)	122 (21.6)	0 (0.00)	1 (0.88)	131 (58.2)	0 (0.00)	1 (1.42)	174 (27.3)	199 (11.4)
of which:													
firms with one PF variable missing	0	5 (0.56)	3 (0.36)	0	1 (0.11)	0	0	0	1 (0.44)	0	0	1 (0.16)	1 (0.06)
firms with two PF variables missing	0	0	0	0	0	0	0	0	0	0	0	0	0
firms with three PF variables missing	1 (0.12)	0	0	0	0	0	0	0	0	0	0	0	0
firms with four PF variables missing	204 (23.9)	229 (25.4)	161 (19.4)	22 (6.88)	180 (20.6)	122 (21.6)	0 (0.00)	1 (0.88)	130 (57.7)	0 (0.00)	1 (1.42)	173 (27.2)	198 (11.4)
Outliers	70 (8.22)	35 (3.89)	106 (12.8)	10 (3.13)	66 (7.59)	25 (4.43)	1 (0.98)	1 (0.88)	16 (7.11)	2 (1.89)	0	46 (7.23)	47 (2.71)
of which:													
outliers in materials	64 (7.51)	13 (1.44)	74 (8.94)	4 (1.25)	35 (4.02)	25 (4.43)	0 (0.00)	1 (0.88)	2 (0.89)	1 (0.94)	0	28 (4.40)	18 (1.04)
outliers in labor cost	2 (0.23)	14 (1.56)	12 (1.45)	4 (1.25)	22 (2.53)	0	1 (0.98)	0	6 (2.67)	1 (0.94)	0	11 (1.73)	13 (0.75)
outliers in both materials and labor cost	4 (0.47)	8 (0.89)	20 (2.42)	2 (0.63)	9 (1.03)	0	0	0	8 (3.56)	0 (0.00)	0	7 (1.10)	16 (0.92)
Available observations after replacing (outliers and missing excluded)	577 (67.7)	635 (70.5)	561 (67.7)	288 (90.0)	623 (71.6)	417 (73.9)	101 (99.0)	112 (98.2)	79 (35.1)	104 (98.1)	69 (98.5)	417 (65.5)	1,492 (85.9)

Source: IC data.

Note: As for previous table.

Table B.2.1 Representativity of PF variables before and after cleaning missing values and outliers, by country and year

		1999		2000		2001		2002		2003		2004		2005		Total
		#Obs	Perc. available	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs
Algeria	Original sample			952		952										1,904
	Without replacing			552	42.0	562	41.0									1,114
	With replacing			700	26.5	712	25.2									1,412
Benin	Original sample					197		197		197						591
	Without replacing					112	43.1	123	37.6	129	34.5					364
	With replacing					143	27.4	164	16.8	168	14.7					475
Botswana	Original sample													114		114
	Without replacing													109	4.4	109
	With replacing													113	0.9	113
Burkina Faso	Original sample													51		51
	Without replacing													50	2.0	50
	With replacing													51	0.0	51
Burundi	Original sample													102		102
	Without replacing													100	2.0	100
	With replacing													101	1.0	101
Cameroon	Original sample													119		119
	Without replacing													117	1.7	117
	With replacing													118	0.8	118
Cape Verde	Original sample													47		47
	Without replacing													47	0.0	47
	With replacing													47	0.0	47
Egypt	Original sample					977		977		977						2,931
	Without replacing					631	35.4	686		0	100					1,317
	With replacing					795	18.6	902		932	4.6					2,629
Eritrea	Original sample	79		79		79										237
	Without replacing	0	100	38	51.9	23	70.9									61
	With replacing	50	36.7	62	21.5	67	15.2									179
Ethiopia	Original sample	427		427		427										1,281
	Without replacing	316	26.0	344	19.4	388	9.1									1,048
	With replacing	351	17.8	377	11.7	414	3.0									1,142
Kenya	Original sample			284		284		284								852
	Without replacing			110	61.3	119	58.1	131	53.9							360
	With replacing			185	34.9	185	34.9	215	24.3							585
Lesotho	Original sample			75		75		75								225
	Without replacing			9	88.0	12	84.0	16	78.7							37
	With replacing			20	73.3	26	65.3	33	56.0							79

Source: Authors' elaboration with IC data.

Note: Original sample includes all establishments surveyed. Without replacing includes establishments without missing values and/or outliers in PF variables. With replacing includes establishments without missing values and/or outliers in the PF variables.

Table B.2.1 (cont.) Representativity of PF variables before and after cleaning missing values and outliers, by country and year

		1999		2000		2001		2002		2003		2004		2005		Total
		#Obs	Perc. available	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs
Madagascar	Original sample							290		290		290				870
	Without replacing							113	61.0	134	53.8	136	53.1			383
	With replacing							183	36.9	212	26.9	228	21.4			623
Malawi	Original sample									160		160				320
	Without replacing									93	41.9	115	28.1			208
	With replacing									136	15.0	152	5.0			288
Mali	Original sample			154		154		154								462
	Without replacing			62	59.7	78	49.4	102	33.8							242
	With replacing			74	51.9	93	39.6	142	7.8							309
Mauritania	Original sample													80		80
	Without replacing													79	1.3	79
	With replacing													80	0.0	80
Mauritius	Original sample							212		212		212				636
	Without replacing							77	63.7	97	54.2	97	54.2			271
	With replacing							122	42.5	142	33.0	153	27.8			417
Morocco	Original sample			850		850		850								2,550
	Without replacing			754	11.3	794	6.6	804	5.4							2,352
	With replacing			780	8.2	813	4.4	829	2.5							2,422
Namibia	Original sample													106		106
	Without replacing													100	5.7	100
	With replacing													104	1.9	104
Niger	Original sample													64		64
	Without replacing													14	78.1	14
	With replacing													48	25.0	48
Senegal	Original sample			261		261		261								783
	Without replacing			59	77.4	84	67.8	110	57.9							253
	With replacing			135	48.3	183	29.9	217	16.9							535
South Africa	Original sample			579		579		579								1,737
	Without replacing			373	35.6	406	29.9	450	22.3							1,229
	With replacing			457	21.1	498	14.0	537	7.3							1,492
Swaziland	Original sample													70		70
	Without replacing													67	4.3	67
	With replacing													69	1.4	69
Tanzania	Original sample			276		276		276								828
	Without replacing			113	59.1	124	55.1	88	68.1							325
	With replacing			193	30.1	205	25.7	163	40.9							561
Uganda	Original sample			300		300		300								900
	Without replacing			102	66.0	112	62.7	154	48.7							368
	With replacing			169	43.7	249	17.0	277	7.7							695
Zambia	Original sample	188		188		188		0								564
	Without replacing	114	39.4	127	32.4	150	20.2	0								391
	With replacing	126	33.0	136	27.7	155	17.6	0								417

Source: Author's elaboration with IC data.

Note: As for first part of table.

Table B.2.2 Representativity of PF variables before and after cleaning missing values and outliers, by country and industry

		Food and beverages		Textiles and apparels		Chemicals, rubber, and plastics		Paper, edition, and publishing		Mach and equipment/metallic products		Wood and furniture		Nonmetallic products		Other manufacturing	
Country		#Obs	Perc. available	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.
Algeria	Original sample	204		372		404		308		440				144		32	
	Without replacing	114	44.1	200	46.2	280	30.7	162	47.4	256	41.8			98	31.9	4	87.5
	With replacing	174	14.7	258	30.6	332	17.8	204	33.8	320	27.3			114	20.8	10	68.8
Benin	Original sample	120		258		36		135		66		189				45	
	Without replacing	71	40.8			29	19.4	75	44.4	37	43.9	125	33.9			27	40.0
	With replacing	98	18.3			34	5.6	110	18.5	48	27.3	147	22.2			39	13.3
Botswana	Original sample	12		27		0										75	
	Without replacing	12	0.0	26	3.7	0										71	5.3
	With replacing	12	0.0	27	0.0	0										74	1.3
Burkina Faso	Original sample	14						12								25	
	Without replacing	13	7.1					12	0.0							25	0.0
	With replacing	14	0.0					12	0.0							25	0.0
Burundi	Original sample	19		24												59	
	Without replacing	18	5.3	24	0.0											58	1.7
	With replacing	19	0.0	24	0.0											58	1.7
Cameroon	Original sample	31				17		19		11		18				23	
	Without replacing	31	0.0			17	0.0	18	5.3	11	0.0	18	0.0			22	4.3
	With replacing	31	0.0			17	0.0	18	5.3	11	0.0	18	0.0			23	0.0
Cape Verde	Original sample	12										16				19	
	Without replacing	12	0.0									16	0.0			19	0.0
	With replacing	12	0.0									16	0.0			19	0.0
Egypt	Original sample	468		915		453				672		174		249			
	Without replacing	225	51.9	393	57.0	219	51.7			303	54.9	67	61.5	110	55.8		
	With replacing	416	11.1	815	10.9	414	8.6			602	10.4	152	12.6	230	7.6		
Eritrea	Original sample	54		51						18						114	
	Without replacing	14	74.1	11	78.4					8	55.6					28	75.4
	With replacing	38	29.6	39	23.5					15	16.7					87	23.7
Ethiopia	Original sample	285		279						618						99	
	Without replacing	233	18.2	207	25.8					531	14.1					77	22.2
	With replacing	258	9.5	240	14.0					557	9.9					87	12.1
Kenya	Original sample	249		141		144				147						171	
	Without replacing	99	60.2	69	51.1	62	56.9			57	61.2					73	57.3
	With replacing	172	30.9	95	32.6	97	32.6			91	38.1					130	24.0
Lesotho	Original sample	54		102												69	
	Without replacing	17	68.5	8	92.2											12	82.6
	With replacing	31	42.6	24	76.5											24	65.2

Source: Author's elaboration with IC data.

Note: As for previous table.

Table B.2.2 Representativity of PF variables before and after cleaning missing values and outliers, by country and industry (cont.)

		Food and beverages		Textiles and apparels		Chemicals, rubber, and plastics		Paper, edition, and publishing		Mach and equipment/metallic products		Wood and furniture		Nonmetallic products		Other manufacturing	
Country		#Obs	Perc. available	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.	#Obs	Perc.
Madagascar	Original sample	150		267		108		93		60		192					
	Without replacing	77	48.7	106	60.3	57	47.2	51	45.2	24	60.0	68	64.6				
	With replacing	110	26.7	175	34.5	76	29.6	76	18.3	44	26.7	142	26.0				
Malawi	Original sample	112				70				42		48				48	
	Without replacing	72	35.7			52	25.7			30	28.6	27	43.8			27	43.8
	With replacing	101	9.8			66	5.7			42	0.0	40	16.7			39	18.8
Mali	Original sample	153		30		69		33		66		54		57			
	Without replacing	82	46.4	8	73.3	29	58.0	19	42.4	47	28.8	23	57.4	34	40.4		
	With replacing	97	36.6	14	53.3	47	31.9	27	18.2	56	15.2	30	44.4	38	33.3		
Mauritania	Original sample	27								12		13				28	
	Without replacing	26	3.7							12	0.0	13	0.0			28	0.0
	With replacing	27	0.0							12	0.0	13	0.0			28	0.0
Mauritius	Original sample	117		219		72		54		93		33		18		30	
	Without replacing	53	54.7	97	55.7	32	55.6	32	40.7	29	68.8	20	39.4	8	55.6	0	100.0
	With replacing	86	26.5	139	36.5	47	34.7	50	7.4	63	32.3	23	30.3	9	50.0	0	100.0
Morocco	Original sample	216		1,722		414				147						51	
	Without replacing	196	9.3	1,584	8.0	383	7.5			140	4.8					49	3.9
	With replacing	205	5.1	1,635	5.1	390	5.8			142	3.4					50	2.0
Namibia	Original sample	18		5												83	
	Without replacing	18	0.0	5	0.0											77	7.2
	With replacing	18	0.0	5	0.0											81	2.4
Niger	Original sample	18						14								32	
	Without replacing	6	66.7					0	100.0							8	75.0
	With replacing	12	33.3					12	14.3							24	25.0
Senegal	Original sample	279		69		147		108		75		48		57			
	Without replacing	78	72.0	20	71.0	55	62.6	48	55.6	19	74.7	15	68.8	18	68.4		
	With replacing	186	33.3	46	33.3	106	27.9	73	32.4	49	34.7	29	39.6	45	21.1		
South Africa	Original sample	189		180		285		159		561		147		66		150	
	Without replacing	131	30.7	107	40.6	187	34.4	120	24.5	435	22.5	102	30.6	43	34.8	104	30.7
	With replacing	162	14.3	144	20.0	241	15.4	137	13.8	498	11.2	131	10.9	50	24.2	129	14.0
Swaziland	Original sample	14		20												36	
	Without replacing	12	14.3	19	5.0											36	0.0
	With replacing	13	7.1	20	0.0											36	0.0
Tanzania	Original sample	243		93		102		75		87		195		33			
	Without replacing	108	55.6	29	68.8	42	58.8	33	56.0	26	70.1	68	65.1	19	42.4		
	With replacing	168	30.9	58	37.6	69	32.4	55	26.7	65	25.3	117	40.0	27	18.2		
Uganda	Original sample	366		45		75		69		63		162		120			
	Without replacing	148	59.6	22	51.1	17	77.3	19	72.5	33	47.6	74	54.3	55	54.2		
	With replacing	292	20.2	37	17.8	58	22.7	44	36.2	53	15.9	120	25.9	91	24.2		
Zambia	Original sample	273		69		63				75						84	
	Without replacing	188	31.1	54	21.7	44	30.2			52	30.7					53	36.9
	With replacing	201	26.4	58	15.9	50	20.6			54	28.0					54	35.7

Source: Authors' elaboration with IC data. *Note*: As for first part of table.

Table B.3.1 Response rate of infrastructure IC variables in the final sample

	Northern Africa					Western Africa—ECOWAS						Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Days to clear customs to import	53.6	23.7	70.5	58.7	32.1	41.1	47.5	41.2	51.1	60.0	52.9	23.7	73.7	61.1		23.3	66.3		64.5	37.6	74.1	76.0	67.0	48.6	65.2	69.8
Longest number of days to clear customs to import	52.3	23.3	70.4	57.3	32.1	41.7	47.5	41.2	51.1	60.0	52.9	23.4	72.6	35.6		22.4			64.5	37.6	73.2	74.7	66.0	48.6	63.8	69.1
Days to clear customs to export	4.0	18.7	58.4	21.3	17.0	15.9	12.5	23.5	4.3	16.3	26.9	6.3	12.8	50.0		41.9	67.0		31.7	1.0	16.1	42.7	23.6	37.1	55.4	59.1
Longest number of days to clear customs to export	4.0	18.3	58.4	21.3	17.0	15.9	12.5	23.5	4.3	16.3	26.9	6.3	12.3	18.0		40.8	23.3		31.7	1.0	16.1	40.0	23.6	37.1	55.4	58.4
Cost to clear customs to export	99.4						12.5	19.6	2.1	7.5	26.9									1.0	13.4		18.9	37.1		
Inspections in customs			62.7				13.8	25.5	4.3	80.0	39.5									2.0	14.3		20.8	35.7		
Shipment losses in customs to export							13.8	25.5	4.3	16.3	37.8									2.0	17.0		24.5	37.1		
Dummy for profit from export facilities				47.2	21.2		16.3	25.5	4.3	17.5	39.5	5.2	12.8	57.7	18.9	26.1	23.3	28.9							65.9	
Cost of exports												99.5														
Dummy for public mechanism to cover risks in exports				47.0	21.8	20.1										43.6	24.7									
Dummy for outside clearing agent for imports				65.0	34.9	20.7	100.0	39.2	51.1	61.3	53.8			59.1	26.6	98.0		43.7	66.4	2.0	17.0		24.5	37.1	68.6	
Average number of days to clear an outgoing container through port						46.9								28.9	12.3			29.4								
Cost to clear an outgoing container through port														22.7	10.6											
Average number of days to clear an incoming container through port														55.1	22.5			42.5								
Cost to clear an incoming container through port														34.6	20.0											
Dummy for own power infrastructure (excl. generator)				99.2		99.0								98.0	100.0											
Dummy for own generator	98.1	99.9	99.6	99.2	100.0	95.5	100.0	98.0	100.0	80.0	100.0	99.7	100.0	97.4	100.0	96.6	100.0	100.0	100.0	100.0	100.0	92.0	98.1	98.6		
Electricity from own generator	98.9	99.8	99.1	89.7	84.5	97.4	100.0	96.1	100.0	75.0	95.8	12.1	97.2	93.5	99.5	0.0	93.4	99.0	98.8	100.0	98.2	82.7	96.2	97.1		
Cost of electricity from generator				37.3	24.4	39.8						93.5	89.4	60.1	32.9	76.7	18.8		95.0							
Cost of electricity from public grid				73.3		93.2						2.8	22.9	89.7	88.0							58.7				
Dummy for equipment damaged by power fluctuations				97.9	95.6	97.4									95.4	95.3		98.7								
Equipment damaged by power fluctuations				83.2		93.9									91.7	93.7		70.1								
Power outages	99.2	96.6	32.5	80.0	87.0	86.7	100.0	98.0	100.0	75.0	95.8	97.1	96.1	89.3	85.7	76.6	90.6	82.2	100.0	97.0	99.1	74.7	96.2	98.6	98.1	65.1
Average duration of power outages		86.6	32.9	86.5	84.0	85.8	100.0	96.1	95.7	71.3	86.6	92.4	96.1	88.5	81.9	75.5	92.4	98.2	100.0	97.0	100.0	84.0	96.2	97.1	97.1	64.2
Power fluctuations				64.4			88.8	74.5	97.9	62.5	90.8			81.4	84.7		84.7		95.9	93.1	90.2		89.6	88.6	95.4	
Average duration of power fluctuations				68.4										73.3	77.3				100.0							
Sales lost due to power outages	99.2	77.0	33.3		83.4	85.8								94.1	88.8	62.3		91.2	98.8			73.3				51.1
Water outages	99.2	54.6	6.8	86.7	79.6	94.2	68.8	98.0	95.7	70.0	97.5	91.3	96.1	87.2	77.2	33.5	89.2	93.4	100.0	50.5	97.3	70.7	50.0	95.7	95.0	29.9
Average duration of water outages		49.6	7.6	86.5	79.2	93.5	68.8	98.0	91.5	68.8	97.5			81.4	76.1	32.6	90.6	94.9	99.5	50.5	97.3	73.3	50.0	95.7	95.7	29.5

Sales lost due to water outages	99.4	50.7	7.1	86.7	65.1	93.5										22.2	85.8	96.8				65.3			94.2	20.2
Dummy for own well or water infrastructure	94.1			5.1	100.0	100.0						99.7	100.0	94.9	97.8	97.5		100.0	100.0	50.5	97.3		50.0	95.7		
Water from own well or water infrastructure		51.8	100.0	96.6	99.8	99.7	68.8	84.3	95.7	73.8	95.8			90.7	100.0	95.2	71.9	100.0				90.7				
Cost of water from own well				71.2	68.5	76.7								43.3	48.8	52.4		67.9								
Cost of water from public system	68.7													52.0												
Phone outages	98.9		7.4	94.3	81.3	87.7						87.2	96.1	92.1	58.4	17.5		87.2	100.0			60.0			97.4	36.4
Average duration of phone outages			8.1	93.9	77.1	87.7								92.1	57.5	15.7		87.5	100.0			62.7			96.6	36.1
Losses due to phone outages			4.0	94.5		86.1										10.7						40.0			70.3	25.9
Transport failures			7.3	29.7		33.0										13.2	89.9		100.0			62.7				30.1
Average duration of transport failures			7.6	29.5		33.0										11.3	90.6		99.3			62.7				29.7
Sales lost due to transport failures			8.1	29.1		36.2										8.4	83.7					64.0				21.8
Average duration of transport																				100.0	88.4		91.5	98.6		
Public postal service interruptions																						57.3				21.6
Average duration of public postal service interruptions																						50.7				21.2
Sales lost due to public postal service interruptions																						2.7				15.2

Source: Authors' elaboration with IC data.

Table B.3.1 Response rate of infrastructure IC variables in the final sample (cont.)

	Northern Africa			Western Africa—ECOWAS								Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Dummy for own roads				99.2	100.0	100.0								96.8	100.0	98.0		100.0							98.8	
Dummy for own transportation for workers				99.2	100.0	100.0								96.8	100.0	98.0		100.0							98.8	
Dummy for own waste disposal				99.2	100.0	99.7								94.3	100.0	98.0		100.0							98.8	
Dummy for contract with transportation company				96.6	96.8	99.0								92.3	81.3	78.2		100.0							98.8	
Dummy for own transportation		99.9	100.0	96.6	96.8	99.0	100.0	98.0	97.9	80.0	100.0			92.3	81.3			100.0		100.0	100.0		98.1	98.6	98.6	
Products with own transport		99.2					100.0	98.0	95.7	77.5	100.0						95.8			100.0	100.0		98.1	98.6	72.9	
Transport delay, outgoing domestic			93.1		53.4									90.3	60.9											
Transport delay, outgoing export			77.9		43.7									88.1	53.1											
Transport delay, incoming domestic			94.4		78.8									89.3	58.6											
Transport delay, incoming international			86.4		44.7									87.0	50.7											
Shipment losses, domestic	99.4	99.0	50.9		83.0		13.8	100.0	97.9	75.0	99.2	98.3	100.0	83.6	21.9	91.1	100.0	98.7	100.0	2.0	17.0	86.7	24.5	37.1	95.9	99.7
Shipment losses, exports		28.8			54.2									67.2	9.9		100.0	65.5							91.8	
Dummy for e-mail	89.3	99.9	72.5	98.9	100.0	98.4	100.0	98.0	100.0	80.0	100.0	99.9	100.0	97.4	100.0	96.2	100.0	100.0	99.3	100.0	100.0	98.7	98.1	98.6	99.5	100.0
Dummy for Web page	85.7	99.8	97.3	99.2	100.0	99.4	100.0	100.0	100.0	80.0	100.0	99.9	100.0	96.6	100.0	94.8	100.0	100.0	99.3	100.0	100.0	98.7	98.1	98.6	96.9	100.0
Wait for phone connection	31.7	13.1	97.5	55.6	53.8	73.5	30.0	21.6	19.1	23.8	16.0	34.3	33.5	61.3	42.8	23.1	48.3	23.8		6.9	24.1	36.0	38.7	20.0	43.9	39.9
Dummy for gifts to obtain a phone connection	0.0	12.6		56.8	56.1	74.1	30.0	23.5	100.0	23.8	16.8			66.0	43.1	30.8	49.3	26.0		13.9	25.9	42.7	38.7	24.3	42.7	39.9
Wait for electric supply	4.2	9.1	94.6	42.7	58.4	69.9	18.8	13.7	8.5	17.5	10.1	27.2	29.6	48.8	52.6	24.0	29.2	14.3		15.8	11.6	25.3	23.6	11.4	27.1	33.7
Dummy for gifts to obtain a electric supply		9.2		44.0	58.4	70.6	18.8	15.7	100.0	16.3	10.1			50.2	54.2	30.2	28.1	14.0		15.8	12.5	37.3	23.6	11.4	27.8	33.7
Wait for a water supply		4.8	94.2	25.5	47.9	65.4	13.8	11.8	6.4	12.5	5.9					17.7	11.5	6.3		0.0	9.8	20.0	14.2	7.1	11.8	30.1
Dummy for gifts to obtain a water supply		4.6		29.1	48.9	65.7	15.0	11.8	100.0	11.3	6.7					25.8	11.8	5.8		0.0	9.8	32.0	14.2	7.1	12.0	30.1
Wait for an import license		9.4		26.9	27.3	49.5	10.0	21.6	19.1	37.5	33.6			46.6	17.8	14.0	22.9	3.2	15.6	19.8	14.3	25.3	21.7	15.7	8.4	26.9
Dummy for gifts to obtain an import license		9.1		32.2	29.4	54.7	11.3	21.6	100.0	38.8	31.1			47.4	18.7	25.2	22.6	5.8		19.8	16.1	33.3	20.8	18.6	8.4	27.1
Low quality supplies	99.4	100.0	98.6	89.7	96.4	97.4						99.1		96.6	94.6	96.8	95.5	99.2	99.5			86.7			97.6	99.7
Sales lost due to delivery delays, domestic	99.4		98.7	75.4	21.8	92.6						99.1		92.9	94.3	85.9	27.8	86.7	99.3			88.0			92.1	99.3
Sales lost due to delivery delays, imports				42.7	93.7	40.1								76.3	30.2		2.1	48.5								
Transport delays in domestic sales			63.6	75.2	86.8	92.9								90.7	94.0	86.0		86.7								
Transport delays in international sales			62.4	43.0	93.7	41.1								75.1	30.2			48.8								
Illegal payments to obtain public utilities				62.7	86.8									62.3	31.7											
Days of inventory of main supply		98.4		89.1		98.4	100.0	94.1	97.9	72.5	98.3	85.3		78.1	91.5	81.9	94.1		99.3	100.0	99.1	86.7	97.2	94.3	95.2	99.0
Days of inventory of finished goods				85.1		98.4						99.6	39.7	96.6	85.7	82.8		90.7							96.4	0.0

Source: Authors' elaboration with IC data.

Table B.3.2 Response rate of red tape, corruption, and crime IC variables in the final sample

	Northern Africa			Western Africa—ECOWAS								Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Manager's time spent in bureaucratic issues	99.4		99.6	83.8	92.9	94.2	100.0	90.2	100.0	76.3	99.2	97.8	98.3	93.1	97.6	96.6	97.9	95.8	100.0	100.0	98.2	92.0	98.1	97.1	98.1	99.1
Payments to deal with bureaucratic issues	20.6	97.6		78.3	88.2	93.9	75.0	45.1	89.4	43.8	68.1			78.5	55.3	90.0	53.5	96.6	77.0	92.1	84.8	72.0	74.5	91.4	80.8	93.3
Illegal payments to obtain licenses				63.2										62.1	31.2											
Illegal payments to tax administrators				60.4																						
Days spent with regulation agencies												98.7	23.5													
Cost dealing with regulation agencies												76.2	11.7													
Wait for a construction permit	99.4		89.4	20.4	30.0	54.4	12.5	7.8	19.1	11.3	4.2			24.3	24.1	9.7	21.5			1.0	6.3	18.7	17.0	4.3		16.1
Dummy for gifts to obtain a construction permit				21.1	32.4	57.9	12.5	7.8	100.0	11.3	5.9			27.5	25.2	2.0	22.6			1.0	8.0	32.0	18.9	7.1		16.4
Wait for an operating license		24.0	96.8	20.6	38.7	56.6	5.0	9.8	12.8	25.0	83.2			81.6	98.6	67.3	34.0			9.9	67.0	37.3	36.8	30.0		25.9
Gifts to obtain a operating license		24.3		24.8	40.3	63.4	5.0	9.8	100.0	25.0	78.2			79.4	97.0	100.0	36.5			9.9	68.8	53.3	35.8	31.4		26.1
Sales declared to taxes	33.2	98.4	98.1	78.1	90.1	96.4	95.0	94.1	87.2	76.3	96.6			87.9	69.9	90.9	83.7	98.9	77.5	100.0	98.2	64.0	95.3	98.6	86.3	94.3
Workforce declared to taxes	99.4	98.5			91.6		96.3	94.1	91.5	71.3	95.8						81.3	100.0		100.0	100.0		94.3	94.3	86.1	
Days in inspections		99.9	99.6	91.8	100.0	90.9	87.5	98.0	100.0	73.8	95.8	99.6	98.3	96.0	99.7	95.3	99.3	75.3	100.0	84.2	49.1	82.7	24.5	70.0	95.9	97.8
Dummy for gifts in inspections		100.0		88.2	89.1	66.7	87.5	82.4	74.5	57.5	61.3			60.5	40.6	90.5	92.7	35.2	96.6	84.2	49.1	12.0	27.4	75.7	6.5	79.1
Dummy for lawyer/consultant to help deal with permissions					38.7														62.8							
Payments to obtain a contract with the government	99.4	98.6		47.6	89.9	89.0	73.8	68.6	93.6	40.0	49.6			49.6	53.5	64.8	94.8	98.7		91.1	87.5	41.3	72.6	92.9	88.7	74.1
Dummy for law-influencing firm				99.8	100.0	100.0								96.2	99.8	95.9		0.0	100.0			93.3				99.8
Overdue payments to private customers	99.4	91.9	98.9	91.0	96.6	96.8	100.0	100.0	100.0	80.0	100.0			90.7	98.3	43.8	96.9	96.1	99.3	100.0	100.0	68.0	98.1	98.6	95.4	98.6
Overdue payments to SOEs		99.4	44.8											51.0	26.9	31.8		0.0	43.4	100.0	100.0	50.7	98.1	98.6		69.4
Weeks to resolve a case of overdue payment		49.9	57.6	70.9	77.9	85.4								82.2	49.8	47.8		87.6	79.1			50.7			85.1	93.4
Overdue payments in courts	99.4	97.1	60.6	92.6	64.1	96.8	100.0	100.0	100.0	80.0	100.0			29.8	18.3	10.0		96.1	47.0			41.3			88.0	93.8
Weeks to resolve an overdue payment in courts		11.8	14.4	17.1	19.7	51.8								26.7	9.6	10.4	18.4	4.3	23.3			14.7			14.4	36.4
Security expenses	68.7		97.2	88.2	81.9	96.1	38.8	82.4	87.2	26.3	82.4	97.4	48.6	93.7	96.4	93.0	94.8	97.3	99.8	39.6	30.4	64.0	28.3	42.9	77.0	99.5
Dummy for security expenses	68.1		97.2	88.2	81.9	96.1	100.0	100.0	97.9	80.0	100.0	97.4	48.6	93.7	96.4	93.0	94.8	97.3	99.8	100.0	100.0	64.0	98.1	98.6	77.0	99.5
Illegal payments in protection			85.6	65.9	83.2	93.2								90.1	91.7	86.6	96.2	98.7	100.0						72.2	99.5
Dummy for payments in protection			85.6	65.9	83.2	93.2								90.1	91.7	86.6	94.8	98.7	100.0						70.3	99.5
Cost to avoid pilferage from workers														90.7												
Dummy for cost to avoid pilferage from workers														90.7												
Crime losses	99.4		96.4	89.9	97.7	94.8	98.8	100.0	100.0	76.3	97.5	95.2		92.1	99.7	36.5	87.2	97.0	99.8	99.0	98.2	44.0	97.2	98.6	95.7	98.6
Dummy for crime losses	99.4		96.4	89.9	97.7	94.8	100.0	100.0	100.0	80.0	100.0	95.2		92.1	99.7	36.5	73.6	97.0	99.8	100.0	100.0	58.7	98.1	98.6	79.9	98.6
Crimes reported to police			6.5	44.2	17.6	75.4						11.6		27.5	33.9	64.6	70.8	22.5	82.7			61.3			15.6	81.9
Crimes solved by police			6.0	18.1	13.2	40.5						8.9		27.7	28.0	34.9	66.0	22.0	65.9			38.7			16.1	69.4
Days of production lost due to civil unrest	99.4			96.4	87.4	94.2						98.4				1.3	99.0	99.5	100.0			58.7			95.0	92.4

Days of production lost due to absenteeism	97.6		93.7	88.0	96.1							98.0				97.6	98.1	98.8			68.0			87.3	88.6
Dummy for tax exemption												97.5	97.2				98.1							95.4	
Dummy for lawsuit in the last 3 years				91.8													99.8								
Dummy for "gifts" for credit				96.2																					
Dummy for interventionist labor regulation	100.0			70.8		7.5	96.1	97.9	80.0	96.6	100.0					99.0			0.0	7.1		3.8	12.9		
Total days spent with licenses																		86.8							
Dummy for accountant to accomplish taxes																		100.0							
Dummy for gifts to tax inspectors																		100.0							
Gifts to tax inspectors																		100.0							
Dummy for labor conflicts											92.5														
Average time to hire a skilled worker											91.5														
Dummy for conflicts with suppliers											98.9														
Dummy for conflicts with clients											99.6														
Cost of entry											20.8	10.6													
Dummy for consultant to help deal with permissions											20.9														

Source: Authors' elaboration with IC data.

Table B.3.3 Response rate of finance and corporate governance IC variables in the final sample

	Northern Africa			Western Africa—ECOWAS								Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Dummy for trade chamber	99.2	99.9	99.1	99.4	100.0	100.0	100.0	100.0	100.0	80.0	100.0	100.0		82.2	100.0	98.4	99.7	99.5	100.0			93.3			99.5	99.7
Dummy for credit line	97.9	99.6	100.0	99.4	96.8	99.7						98.9	98.9	95.3	100.0	94.3	100.0	100.0	100.0	100.0	100.0	89.3	98.1	98.6	98.1	100.0
Credit unused	97.9	99.9	100.0	91.2	21.2	95.5	100.0	100.0	100.0	80.0	100.0					94.3	64.6	97.6	99.3			82.7			83.0	74.6
Dummy for loan	100.0	100.0	100.0	96.6	96.2	98.7	100.0	100.0	100.0	80.0	100.0	99.5	98.9	91.3	100.0	44.0	100.0	100.0	100.0	100.0	100.0	100.0	98.1	98.6	97.6	100.0
Dummy for loan with collateral	100.0	97.7	53.2	99.8	27.1	100.0	17.5	13.7	31.9	11.3	16.8	94.7	45.3	44.7	21.6	44.0	99.3	100.0	100.0	100.0	100.0	14.7	98.1	98.6	97.4	88.9
Value of the collateral	87.0	99.7	44.8	79.6	20.8	90.0	100.0	98.0	100.0	75.0	98.3	62.2	38.0	34.4	18.6	41.7	89.9	97.8	100.0	12.9	21.4		27.4	14.3	87.3	89.3
Interest rate of the loan	94.7		44.5	93.3	26.3	95.8	100.0	100.0	100.0	80.0	100.0			40.1	20.0	44.0	97.2	97.9	98.8	100.0	97.3	13.3	97.2	98.6	94.7	66.0
Dummy for short-term loan		21.0	52.4	62.9	75.6	67.0									5.2	18.6	97.6	81.5		100.0	100.0	100.0	98.1	98.6	98.3	100.0
Borrows in foreign currency	99.4	99.9		93.9	40.1	93.2	100.0	100.0	100.0	80.0	100.0			77.7	95.4	85.0	96.5	22.0	70.3	100.0	100.0	18.7	98.1	98.6		95.5
Dummy for external auditory			99.1	99.8	97.7	100.0	100.0	98.0	100.0	77.5	95.8	99.4	98.9	98.0	100.0	99.8	100.0	100.0	100.0			88.0			98.8	98.6
Owner of the lands				97.1	90.3	80.6								94.5	96.9	88.2	100.0		100.0	100.0	100.0	92.0	98.1	98.6	91.6	99.8
Owner of the buildings				98.7	100.0	91.3								95.5	99.4	95.7	100.0		100.0			90.7			95.2	99.5
Dummy for owner of the buildings												99.7														
Dummy for owner of the buildings and lands		98.0					100.0	92.2	95.7	80.0	94.1	99.2														
Largest shareholder	99.4	100.0	96.6	93.7	95.0	96.1	100.0	100.0	97.9	80.0	99.2	16.1	16.8	95.7	95.1	95.7	97.2	95.8	99.3	100.0	100.0	98.7	94.3	95.7	96.6	98.6
Working capital financed by internal funds	89.9	100.0	99.8	95.8	96.6	93.9	100.0	100.0	97.9	80.0	99.2	98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0	100.0	99.1	80.0	98.1	98.6	93.3	99.0
Working capital financed by commercial banks	89.9	100.0	99.8	95.8	96.6	93.9						98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0	100.0	99.1	80.0	98.1	98.6	93.3	99.0
Working capital fin. by foreign commercial banks		100.0	99.8	95.8	96.6	93.9						98.5		93.1	99.8	94.3	98.6	99.5	99.0			80.0			93.3	99.0
Working capital financed by leasing		100.0	99.8	95.8	96.6	93.9						98.5		93.1	99.8	94.3	98.6	99.5	99.0			80.0			93.3	99.0
Working capital financed by state services		100.0	99.8	95.8	96.6	93.9	100.0	100.0	97.9	80.0	99.2	98.5	98.9	93.1	99.8	94.3	98.6		99.0			80.0				99.0
Working capital fin. by supplier or customer credit	89.9	100.0	99.8	95.8	96.6	93.9						98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0	100.0	99.1	80.0	98.1	98.6	93.3	99.0
Working capital financed by credit cards		100.0	99.8	95.8	96.6	93.9								93.1	99.8	94.3	98.6	99.5	99.0			80.0			93.3	99.0
Working capital financed by equity		100.0	99.8	95.8	96.6	93.9	100.0	100.0	97.9	80.0	99.2	98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0			80.0			93.3	99.0
Working capital financed by family/friends	89.9	100.0	99.8	95.8	96.6	93.9	100.0	100.0	97.9	80.0	99.2	98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0	100.0	99.1	80.0	98.1	98.6	93.3	99.0
Working capital financed by informal sources		100.0	99.8	95.8	96.6	93.9						98.5	98.9	93.1	99.8	94.3	98.6	99.5	99.0	100.0	99.1	80.0	98.1	98.6	93.3	99.0
Working capital financed by other funds		73.3	99.8	95.8	96.6	93.9	35.0	96.1	93.6	77.5	80.7	98.5		93.1	99.8	94.3	98.6	70.9	99.0			80.0			93.3	99.0
New investments financed by internal funds	62.8	73.3	90.5	90.3	85.3	77.7	35.0	96.1	93.6	77.5	80.7	42.6	77.1	70.6	66.6	60.8	68.8	70.9	71.2	51.5	48.2	56.0	56.6	62.9	79.9	89.6
New investments financed bcommercial banks	62.8	73.3	90.5	90.3	85.3	77.7						42.6	77.1	70.6	66.6	60.8	68.8	70.9	71.2	51.5	48.2	56.0	56.6	62.9	79.9	89.6
New investments fin. by foreign commercial banks		73.3	90.5	90.3	85.3	77.7						42.6		70.6	66.6	60.8	68.8	70.9	71.2			56.0			79.9	89.6

New investments financed by leasing		73.3	90.5	90.3	85.3	77.7						42.6		70.6	66.6	60.8	68.8	70.9	71.2			56.0			79.9	89.6
New investments financed by state services		73.3	90.5	90.3	85.3	77.7	35.0	96.1	93.6	77.5	80.7	42.6		70.6	66.6	60.8	68.8		71.2			56.0				89.6
New investments fin. by supplier or customer credit	62.8	73.3	90.5	90.3	85.3	77.7						42.6		70.6	66.6	60.8	68.8	70.9	71.2	51.5	48.2	56.0	56.6	62.9	79.9	89.6
New investments financed by credit cards		73.3	90.5	90.3	85.3	77.7								70.6	66.6	60.8	68.8	70.9	71.2			56.0			79.9	89.6
New investments financed by equity		73.3	90.5	90.3	85.3	77.7	35.0	96.1	93.6	77.5	80.7	42.6	77.1	70.6	66.6	60.8	68.8	70.9	71.2			56.0			79.9	89.6
New investments financed by family/friends	62.8	73.3	90.5	90.3	85.3	77.7	35.0	96.1	93.6	77.5	80.7	42.6	77.1	70.6	66.6	60.8	68.8	70.9	71.2	51.5	47.3	56.0	56.6	62.9	79.9	89.6
New investments financed by informal sources		73.3	90.5	90.3	85.3	77.7						42.6	77.1	70.6	66.6	60.8	68.8	70.9	71.2	51.5	48.2	56.0	57.5	62.9	79.9	89.6
New investments financed by other funds		75.5	90.5	90.3	85.3	77.7						42.6		70.6	66.6	60.8	68.8	70.9	71.2			56.0			79.9	89.6
Share of net profits reinvested		99.8	96.9	83.0	69.1	92.9	100.0	100.0	100.0	80.0	100.0			90.1	79.1	90.5	76.7	78.0	68.1			82.7			95.0	98.3
Sales bought on credit				97.9		95.1						100.0		94.5	99.5	97.3	100.0	98.4	100.0	100.0	100.0	84.0	98.1	98.6		
Dummy for inputs bought on credit		99.4		99.8	99.4	99.7	100.0	100.0	100.0	78.8	99.2			95.3	99.8	98.4		99.5	98.6							
Inputs bought on credit				96.2	57.4	97.7								85.6	99.8	97.9	99.3	99.0		100.0	98.2		98.1	97.1		
Time to pay off the credit for inputs														87.4	62.0	61.7		99.0								
Inputs bought on credit with delayed payment				68.8																						
Wait to clear a check			99.6		88.0							77.2	97.2			81.2		95.3	99.0			61.3			96.9	90.8
Charges to clear a check												52.0	86.0			37.9			74.6			14.7				11.4
Wait to clear a domestic currency wire			99.2		87.2							43.2	21.8			52.1		88.6	76.0			32.0			80.6	86.4
Charges to clear a domestic currency wire												28.1	19.0			36.0			58.0			13.3				9.7
Wait to clear a foreign currency wire			96.1		63.9							11.8	10.1			34.5		61.3	82.3			48.0			83.0	68.9
Charges to clear a foreign currency wire												6.0	10.1			6.3			64.7			6.7				10.9
Wait to clear a letter of credit																			25.7							47.3
Charge to clear a letter of credit																			18.9							8.1
Delay of payments of domestic clients				91.8		96.4								83.6	95.3											
Charges to get payments from domestic clients				70.3		84.8								48.2	71.0											
Delay of payments of foreign clients				51.2		31.7								48.6	22.2											
Charges to get payments from foreign clients				36.6		20.4	100.0	98.0	97.9	80.0	100.0			28.5	16.7											
Dummy for current or saving account		99.6												93.7	99.2	96.1		99.8		100.0	100.0		98.1	98.6		
Dummy for foreign current or saving account															99.2		100.0									
Dummy for accountant				99.8	95.0	99.4												100.0								

Source: Authors' elaboration with IC data.

Table B.3.4 Response rate of quality, innovation, and labor skills IC variables in the final sample

	Northern Africa					Western Africa—ECOWAS						Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Dummy for foreign technology		99.0	99.3	97.3	100.0	99.0	100.0	100.0	100.0	53.8	99.2			91.3		98.4	100.0	100.0	98.6	100.0	100.0	94.7	98.1	98.6	99.5	100.0
Dummy for ISO quality certification		100.0	99.1	99.6	99.4	100.0	98.8	98.0	100.0	56.3	100.0	100.0	97.2	98.0		97.9	98.6	100.0	100.0	100.0	100.0	93.3	98.1	98.6	99.5	99.3
Sales with warranty												99.9														
Dummy for new product	99.4	100.0	100.0		100.0		100.0	100.0	100.0	55.0	99.2	98.5		94.7		98.4	100.0	100.0	100.0	100.0	100.0	89.3	97.2	98.6	98.8	99.7
Dummy for product improvement		99.8	100.0		99.4		100.0	100.0	100.0	80.0	99.2			94.7		98.4	100.0	100.0	100.0	100.0	100.0	90.7	97.2	98.6	99.5	99.7
Dummy for discontinued product line																										99.7
Dummy for equipment improvement																	100.0									
Dummy for R&D		99.8		87.0	98.1	89.3	100.0	100.0	100.0	80.0	100.0	98.7	78.8	89.9		99.1	100.0									
R&D expenditures		100.0		69.5	81.9	80.9	100.0	100.0	97.9	80.0	96.6	95.4	40.2	74.3		91.1										
Workers engaged in design/R&D												97.3														
Dummy for subcontracted R&D				97.5								100.0														
Royalties expenditures												98.4														
Dummy for new technology	37.4		100.0	99.8	100.0									96.4	100.0	98.4		100.0	100.0			90.7			99.5	99.7
Dummy for joint venture		99.9	99.8													98.4			100.0			86.7				99.7
Dummy for new license agreement		100.0	99.4													98.4	100.0		100.0			88.0				99.7
Dummy for outsourcing		100.0	99.5													98.4	100.0		100.0	100.0	100.0	77.3	98.1	98.6		99.7
Dummy for in-house production			99.5													97.9	100.0		100.0			76.0				99.5
Dummy for new plant																										99.7
Dummy for closed plant																										99.7
Staff—management			100.0	97.1	98.7	99.4						88.1	100.0	91.3	97.6	93.0	97.6	97.1	100.0			78.7				100.0
Staff—professional workers	68.7	99.5	100.0	95.6	98.9	98.4						88.2	98.3	91.5	97.6	62.3	98.3		99.3			57.3			82.0	100.0
Staff—skilled workers	68.7	99.5	100.0	95.4	98.7	98.7	100.0	100.0	100.0	72.5	97.5	87.9	100.0	91.5	97.6	84.3	97.6	97.1	100.0	100.0	99.1	65.3	97.2	98.6	80.3	100.0
Staff—unskilled workers	68.7	99.5	100.0	95.4	98.7	98.7	100.0	100.0	100.0	72.5	97.5	87.6	98.3	90.9	98.1	66.7	96.9	96.6	100.0	100.0	99.1	64.0	97.2	98.6	77.5	100.0
Staff—nonproduction workers	68.7	99.5	100.0	95.4	98.9	98.4						87.0	100.0	91.5	98.1	70.3	96.9	96.6	100.0			57.3			76.7	100.0
Staff—foreign nationals			96.4	0.0										85.2	98.3		95.8		99.3			78.7				99.3
Average education of staff												95.2														
Average tenure of staff												94.3														
Average age of staff												95.4														
Dummy for training	97.1	99.8	99.5	99.4	92.6	100.0	100.0	100.0	100.0	80.0	100.0	96.8	93.3	93.3	100.0	85.9	99.3	100.0	100.0	100.0	100.0	92.0	98.1	98.6	96.6	100.0
Training to skilled workers	89.1	99.2	98.4	25.3	55.7	23.9	100.0	100.0	100.0	78.8	100.0	98.7	8.9	87.7	91.5	93.0	97.2	98.2	100.0			89.3			81.8	97.6
Training to unskilled workers	89.1	98.9	97.5	23.0	23.1	17.2	100.0	100.0	100.0	78.8	100.0	98.6	14.5	76.9	79.2	89.4	97.9	99.2	99.0			84.0			74.3	95.5
Training to production workers		99.2	96.7																	100.0	100.0		98.1	98.6		
Training to nonproduction		98.7	96.7																	100.0	100.0		96.2	98.6		
Weeks of training for skilled workers				16.0	22.1	19.1	100.0	80.4	70.2	72.5	79.8			75.9	91.0	69.8	88.2	97.8	94.2			86.7			87.5	96.0
Weeks of training for unskilled workers				4.4	8.6	3.2	100.0	80.4	70.2	70.0	79.8			56.7	79.2	55.6	69.1	98.1	78.9			82.7			83.0	91.2
Workforce with computer	99.4		98.7	98.1	100.0	99.4								83.4	99.5	97.5			98.6						84.2	84.8
University staff		97.1	100.0	80.8	90.8	79.3						96.8	91.6	79.1	97.0	89.4		74.3	96.9			77.3				99.8
Dummy for university staff							100.0	96.1	91.5	62.5	99.2									100.0	99.1		96.2	97.1		
Manager's education		99.9	99.2	96.4	32.1	99.4	100.0	100.0	100.0	80.0	100.0	99.1	100.0	98.0	99.1		99.3	26.3	99.3	100.0	100.0	92.0	98.1	98.6	100.0	99.8
Manager's experience		99.8	98.8	83.0	98.1	98.4	100.0	98.0	100.0	76.3	99.2	99.7	100.0	66.4	79.7	80.1	96.5		98.8	100.0	100.0	77.3	98.1	98.6	74.6	99.8

Source: Authors' elaboration with IC data.

Table B.3.5 Response rate of other control C variables in the final sample

	Northern Africa				Western Africa—ECOWAS							Horn of Africa		Eastern Africa—EAC			Southern Africa—SADC (incl. Burundi)								MUS	ZAF
	DZA	EGY	MAR	SEN	BEN	MLI	MRT	BFA	CPV	NER	CMR	ETH	ERI	KEN	UGA	TZA	MWI	MDG	ZMB	BDI	BWA	LSO	NAM	SWZ		
Age	99.4	99.7	100.0	99.2	99.6	99.7	100.0	100.0	100.0	33.8	100.0	100.0	100.0	97.4	99.4	98.9	97.9	99.7	99.3	100.0	100.0	100.0	98.1	95.7	98.8	99.8
Dummy for incorporated company	98.5	99.4	99.9	99.8	100.0	99.7	100.0	100.0	100.0	80.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.1	98.6	96.4	100.0
Dummy for limited company	99.2	99.4	99.9	99.8	100.0	99.7	100.0	100.0	100.0	80.0	100.0	100.0		98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	98.1	98.6	100.0	100.0
Dummy for SOE	98.7	100.0	100.0	99.2	100.0	99.7	100.0	100.0	100.0	80.0	100.0	100.0	100.0	98.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	94.7	98.1	98.6	100.0	100.0
Dummy for FDI	98.7	100.0	100.0	99.2	100.0	99.7	100.0	100.0	100.0	80.0	100.0	98.6	100.0	98.0	100.0	97.9	100.0	100.0	100.0	100.0	100.0	94.7	98.1	98.6	100.0	100.0
Dummy for holdings				99.8	100.0	99.7						100.0		94.1	100.0	20.0	100.0	100.0	100.0			98.7			98.8	100.0
Share of the local market	41.0		64.1	53.5	82.4	83.8	93.8	62.7	83.0	61.3	92.4			78.1		96.6				96.0	98.2	57.3	90.6	81.4		92.9
Share of the national market	36.6		63.2	52.4	83.0	79.3	90.0	66.7	72.3	60.0	84.0			94.5	62.2	86.9	82.3	49.4	75.8	98.0	96.4	40.0	88.7	81.4	57.3	93.3
Dummy for direct exports	97.5	99.7	99.9	96.4	95.8	87.4	100.0	100.0	100.0	80.0	100.0	98.9	100.0	65.0	99.5	98.9	99.3	99.7	100.0	100.0	100.0	86.7	98.1	98.6	97.6	99.5
Share of exports	97.5	99.7	99.9	96.4	95.8	87.4	100.0	100.0	100.0	80.0	100.0	98.9	100.0	94.5	99.5	98.9	99.3	99.7	100.0	100.0	100.0	86.7	98.1	98.6	97.6	
Exporting experience	97.7	97.4	99.9	94.9	92.4	91.9	100.0	100.0	100.0	72.5	100.0	98.0		92.1	17.8	27.2	99.3	31.9	98.8	100.0	99.1	89.3	97.2	94.3	97.6	
Dummy for direct imports		97.9	100.0	90.1	97.9	92.9	68.8	100.0	100.0	80.0	100.0	98.9	100.0	92.9	92.6	93.6	99.0	97.6	92.6	78.2	100.0	100.0	98.1	98.6	93.8	97.4
Share of imports		99.9	100.0	90.1	97.9	92.9	100.0	100.0	100.0	80.0	100.0	97.9	100.0	94.1	93.7	94.8	99.3	99.0	100.0	100.0	100.0	93.3	98.1	98.6	93.8	
Number of competitors	94.3	83.2			95.0							65.4		94.5	98.6	96.1	99.3	72.4	63.5			86.7			72.7	99.5
Capacity utilization	95.2	99.7	99.2	82.7	97.7	98.4	100.0	96.1	91.5	53.8	99.2	87.0	100.0	90.1	94.8	99.5	97.6	95.2	99.8	100.0	98.2	89.3	95.3	94.3	97.1	98.1
Trade union	99.4	95.9	97.3	95.6	97.5	98.7	98.8	100.0	100.0	76.3	100.0	98.6	93.9	91.3	99.4	91.6	100.0	94.7	86.3	100.0	100.0	64.0	97.2	95.7	97.1	99.1
Dummy for privatized firm	97.7	98.1		97.3	98.5	98.7						95.6	100.0	89.5		93.7	97.6	96.8	100.0			98.7			96.9	100.0
Dummy for industrial zone		99.9	100.0	99.2	99.2	99.7	100.0	96.1	100.0	80.0	98.3	97.6	100.0	98.0	100.0	98.6	99.3			100.0	100.0		98.1	98.6	99.5	0.0
Days of production lost due to strikes	99.4	97.4		96.4	87.4	95.5						98.8		89.7	98.9	1.6	65.3	99.5	100.0			65.3			95.0	92.6
Workers infected by HIV				68.2	65.1	57.0								56.3			98.3	70.0							80.8	35.4
Dummy for negative impact of HIV				64.4	76.7	90.6	100.0	98.0	97.9	80.0	99.2	99.9		84.0	94.3	94.8	91.0	64.8		98.0	100.0	62.7	93.4	98.6	88.2	100.0
Cost in HIV-prevention programs				67.0	75.8	75.1						99.9		19.0	66.3	48.7	87.5	78.5							90.9	44.7

Source: Authors' elaboration with IC data.

Table B.4 Classification of the main infrastructure variables (INFs)

	Name of the variable	Description of the variable
Customs clearance	Days to clear customs to import	Average number of days to clear customs when importing (logs)
	Days to clear customs to export	Average number of days to clear customs when exporting directly (logs)
	Wait for an import license	Number of days waiting for an import license (logs)
Energy/ Electricity	Dummy for own power infrastructure	Dummy taking value 1 if the firm provides its own power infrastructure, excluding generators
	Dummy for own generator	Dummy variable taking value 1 if the firm has its own power generator
	Electricity from own generator	Percentage of the electricity used by the plant provided by the own generator
	Cost of electricity from generator	Estimated annual cost of generator fuel as percentage of annual sales
	Cost of electricity from public grid	Average cost per kilowatt-hour (Kw/H) when using power from the public grid (logs)
	Dummy for equipment damaged by power fluctuations / Equipment damaged by power fluctuations	Dummy taking value 1 if any machine or equipment was damaged by power fluctuations / Value of the losses of machinery and equipment damaged by power fluctuations as a percentage of the net book value of machinery and equipment (NBVC)
	Power outages / Average duration of power outages / Sales lost due to same	Total number of (logs) / Average duration of (logs) / Percentage of sales loss due to power outages suffered by the plant in the last fiscal year (LFY) (conditional on the plant reports having power outages)
	Power fluctuations / Average duration of power fluctuations	Total number of (logs) / Average duration of (logs) power fluctuations suffered in hours (conditional on the plant reports having power fluctuations)
	Wait for electric supply	Number of days waiting to obtain an electricity supply (logs)
Water	Water outages / Average duration of water outages /Losses due to same	Total number of (logs) / Average duration of (logs) / Percentage of sales lost due to water outages suffered by the plant in LFY (conditional on the plant reports having water outages)
	Dummy for own well or water infrastructure	Dummy taking value 1 if the plant has its own or shared borehole or well or builds its own water infrastructure
	Water from own well or water infrastructure	Percentage of firm's water supply from its own or shared well
	Cost of water from own well	Total annual cost of self-provided water as a percentage of total annual sales
	Cost of water from public system	Unit cost of using water from the public water system (logs)
	Wait for a water supply	Number of days waiting for a water supply (logs)
Telecom. and ICT	Phone outages / Average duration of phone outages / Losses due to same	Total number of (logs) / Average duration of (logs) / Percentage of sales lost due to phone outages suffered by the plant in LFY (conditional on the plant reports having phone outages)
	Wait for phone connection	Number of days waiting to obtain a phone connection (logs)
	Dummy for e-mail	Dummy variable taking value 1 if the plant mainly uses e-mail to communicate with clients and suppliers
	Dummy for web page	Dummy variable taking value 1 if the plant uses its own Web page to communicate with clients and suppliers
Transport	Transport failures / Average duration of transport failures / Sales lost due to same	Total number (logs) of / Average duration of (logs)/ Percentage of sales lost due to transport failures suffered by the plant in LFY (conditional on the plant reporting on transport failures)
	Dummy for own roads	Dummy taking value 1 if the firm provides its own roads
	Dummy for own transportation for workers	Dummy taking value 1 if the firm provides its own transportation for workers
	Dummy for contract with transportation company	Dummy taking value 1 if the firm arranges transport services for the delivery of finished products or raw materials by directly contracting with the transportation company
	Dummy for own transportation	Dummy taking value 1 if the firm arranges transport services for the delivery of finished products or raw materials with its own transportation
	Products with own transport	Percentage of products delivered with firm's own transport
	Transport delay	Percentage of times that transport services are late in picking up sales for domestic (or international) markets at the plant for delivery
	Shipment losses	Percentage of the consignment value of the products shipped for domestic (or international) transportation lost while in transit because of theft, breakage, or spoilage
	Sales lost due to delivery delays	Percentage of domestic (or international) sales lost due to delivery delays from suppliers in LFY
	Low quality supplies	Percentage of domestic inputs/supplies that are of lower than agreed-upon quality

Source: ICS data.

Table C.1 Summary of cross-country comparisons based on alternative rankings of economic performance

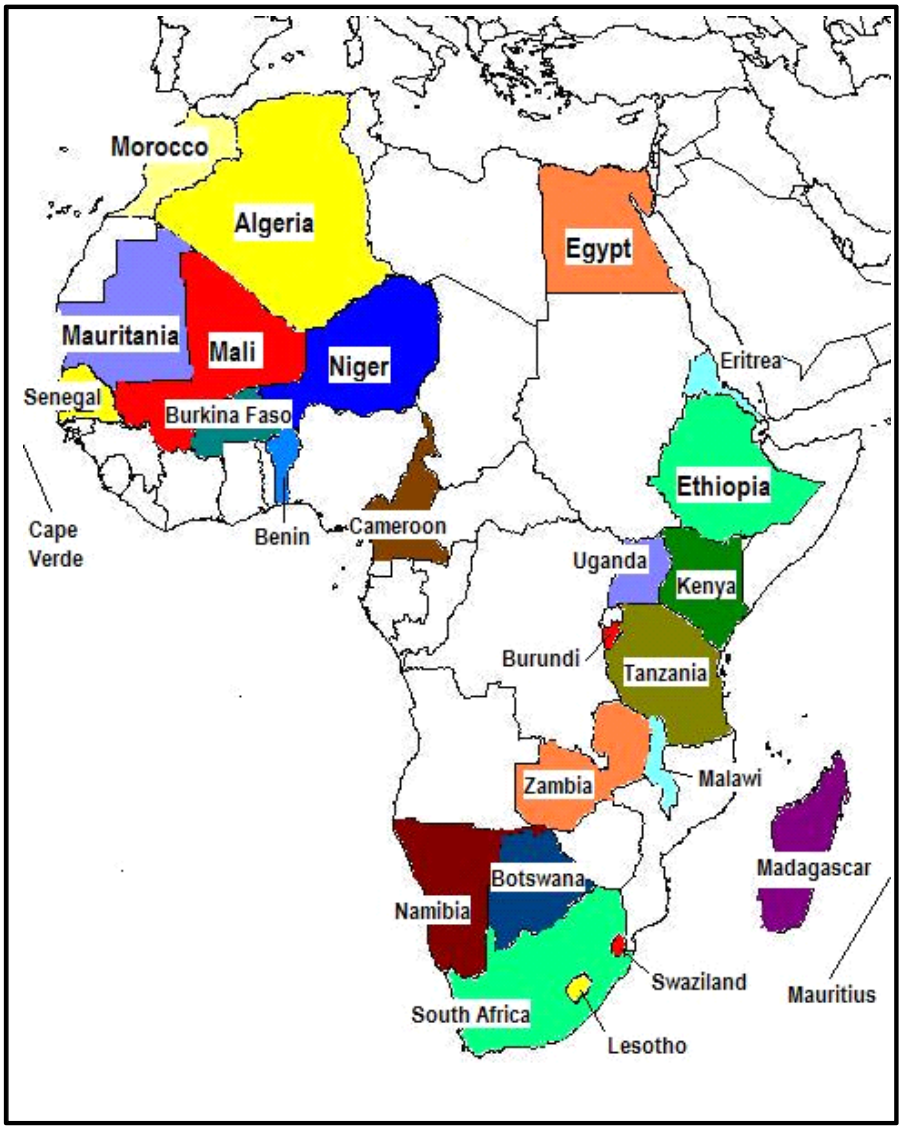
Ranking based on per capita GDP	DBR 2007 (rank)	Ranking ACR'07 (rank within sample)	*Demeaned* Aggregate Productivity (rank)	Firms' perceptions: infras. As an obstacle	Perc. Contributions of infrastructure to log-productivity		Perc. contributions of infrastructure to productivity via simulations	
				% abs. contribution (rank)	Average log-productivity	Allocative efficiency in logs	Average productivity	Allocative efficiency
					% abs. contribution (rank)	% abs. contribution (rank)	% abs. contribution (rank)	% abs. contribution (rank)
MUS (1)	32 (2)	2.0 (2)	4.2 (1)	13.9 (2)	26.6 (19)	17.1 (18)	21.8 (6)	12.4 (4)
SWZ (2)	76 (5)	1.4 (7)	n.a	22.4 (10)	25.6 (21)	14.3 (20)	27.4 (10)	17.6 (10)
ZAF (3)	29 (1)	2.3 (1)	4 (3)	16.2 (5)	28.6 (18)	19.7 (17)	17.4 (4)	11.0 (2)
BWA (4)	48 (4)	1.7 (3)	3.4 (6)	15.6 (4)	17.5 (22)	7.41 (23)	23.2 (8)	8.8 (1)
DZA (5)	116 (12)	1.5 (4)	2.9 (7)	18.3 (7)	48.6 (7)	31.1 (4)	34.9 (18)	26.4 (17)
NAM (6)	42 (3)	1.5 (6)	4.2 (2)	18.3 (6)	16.5 (23)	32.9 (3)	22.7 (7)	36.7 (20)
EGY (7)	165 (22)	1.5 (5)	3.7 (4)	14.0 (3)	26.0 (20)	23.8 (12)	19.9 (5)	16.1 (8)
MAR (8)	115 (11)	1.1 (9)	3.6 (5)	9.9 (1)	31.3 (15)	16.6 (19)	16.2 (3)	14.8 (6)
CMR (9)	152 (18)	0.8 (16)	1.9 (18)	27.5 (23)	41.6 (10)	25.4 (11)	31.2 (13)	23.2 (13)
MRT (10)	148 (16)	0.6 (19)	2.1 (15)	25.3 (17)	35.4 (11)	21.1 (15)	28.3 (12)	16.2 (9)
SEN (11)	146 (15)	0.9 (12)	n.a	22.7 (11)	58.5 (3)	40.9 (2)	52.1 (21)	42.2 (22)
BEN (12)	137 (13)	0.6 (20)	2.1 (11)	25.6 (18)	59.9 (2)	12.4 (21)	33.3 (17)	23.3 (14)
KEN (13)	83 (6)	1.0 (11)	2.8 (8)	25.6 (19)	30.3 (17)	19.9 (16)	26.1 (9)	23.2 (12)
MLI (14)	155 (19)	0.9 (14)	2.1 (14)	21.6 (9)	42.7 (9)	26.8 (9)	42.5 (19)	33.5 (19)
UGA (15)	107 (9)	0.6 (21)	2 (17)	23.3 (12)	58.4 (4)	29.8 (5)	45.4 (20)	42.0 (21)
BFA (16)	163 (21)	0.8 (15)	2.1 (12)	26.9 (22)	35.3 (12)	27.0 (8)	27.6 (11)	12.0 (3)
ZMB (17)	102 (8)	0.7 (18)	n.a	24.0 (14)	50.6 (6)	26.8 (10)	15.4 (2)	15.1 (7)
TZA (18)	142 (14)	0.2 (23)	2.7 (9)	24.3 (15)	34.1 (14)	28.3 (6)	32.3 (15)	29.1 (18)
NER (19)	160 (20)	0.8 (17)	n.a	26.2 (20)	34.7 (13)	11.1 (22)	31.6 (14)	22.1 (11)
MWI (20)	110 (10)	0.4 (22)	2.1 (13)	24.5 (16)	65.9 (1)	45.8 (1)	53.7 (22)	55.2 (23)
MDG (21)	149 (17)	1.4 (8)	2 (16)	23.5 (13)	30.6 (16)	27.9 (7)	11.1 (1)	14.3 (5)
ETH (22)	97 (7)	1.0 (10)	2.3 (10)	26.7 (21)	52.6 (5)	21.9 (14)	33.2 (16)	25.0 (15)
ERI (23)	170 (23)	0.9 (13)	n.a	20.7 (8)	46.1 (8)	22.5 (13)	54.7 (23)	25.3 (16)

Source: Authors' calculations using ICA data, DBR (2007), ACR (2007), and Penn World Table.

Note: n.a = not available.

Figures from section 1

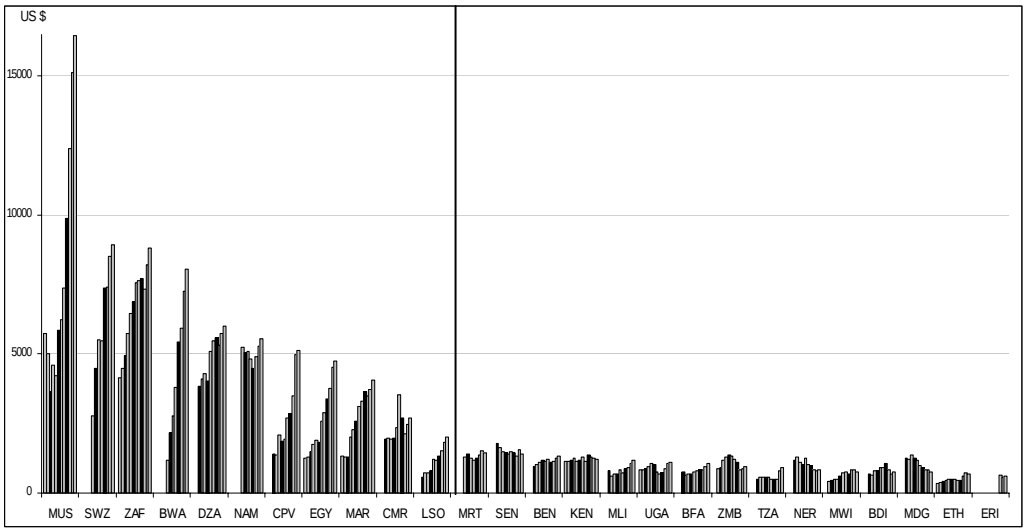
Figure 1.1 Geographical locations of the 26 countries considered in the investment climate assessment (ICA)



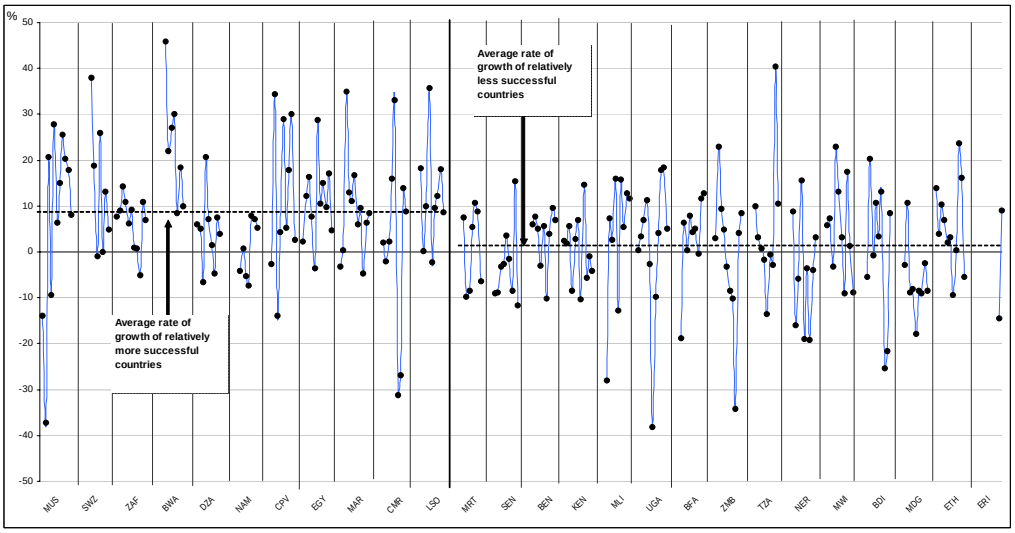
Source: Authors' elaboration.

Figure 1.2 The evolution of gross domestic product (GDP) per capita and ranking based on the ease of doing business in African countries

A. Country by country evolution of GDP per capita, 1950 - 2003



B. Country by country five-year rate of growth of GDP per capita, 1950 - 2003

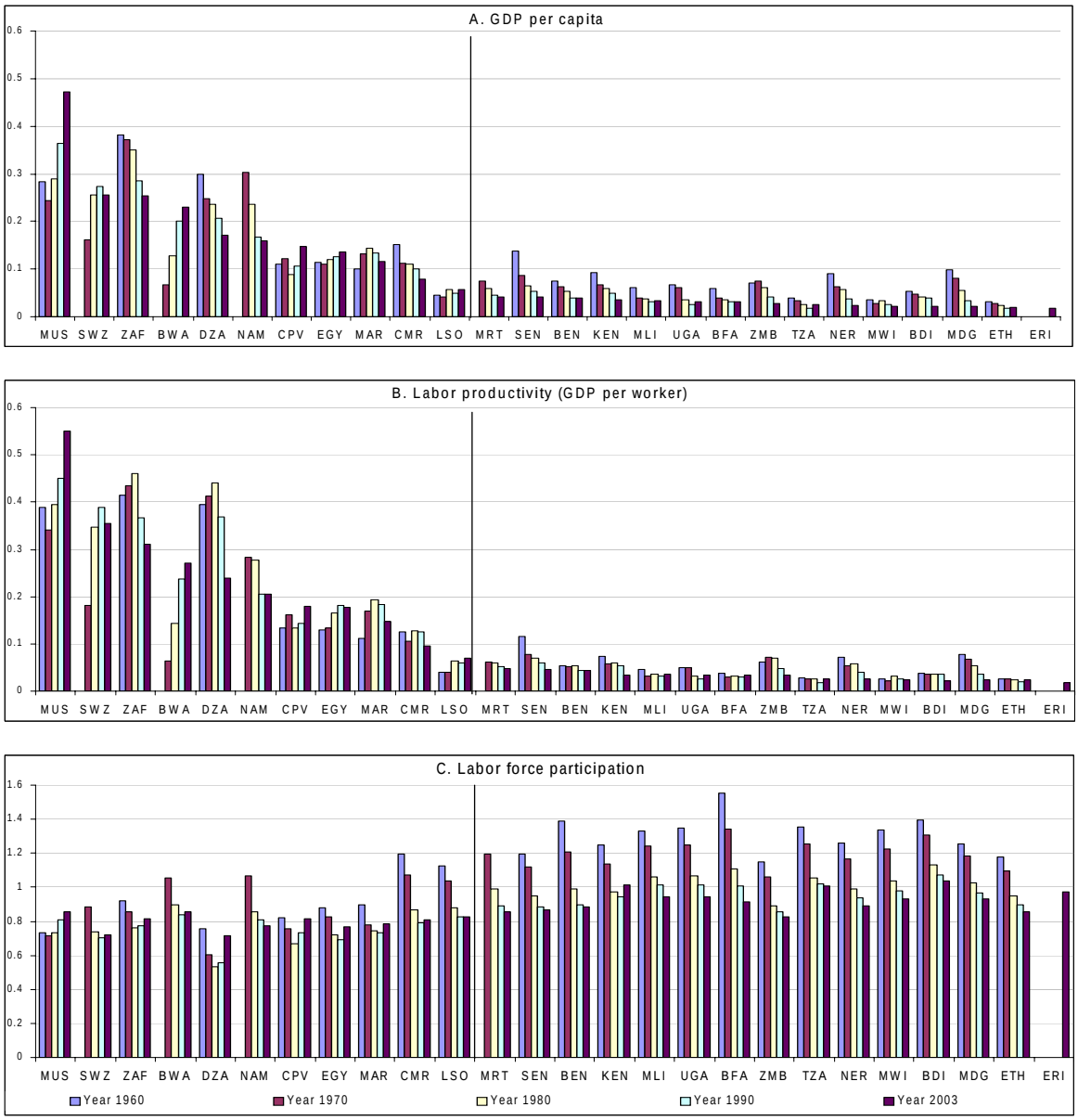


C. Ranking of countries on the ease of doing business, World Bank's Doing Business Report

	MUS	SWZ	ZAF	BWA	DZA	NAM	CPV	EGY	MAR	CMR	LSO	MRT	SEN	BEN	KEN	MLI	UGA	BFA	ZMB	TZA	NER	MWI	BDI	MDG	ETH	ERI
2007	32	76	29	48	116	42	125	165	115	152	114	148	146	137	83	155	107	163	102	142	160	110	166	149	97	170
2006	32	67	28	44	123	39	125	165	117	147	116	146	152	139	80	166	103	171	92	150	170	106	160	148	96	168

Source: Source: Penn World Table, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, 2006 and World Bank's Doing Business Report 2007.

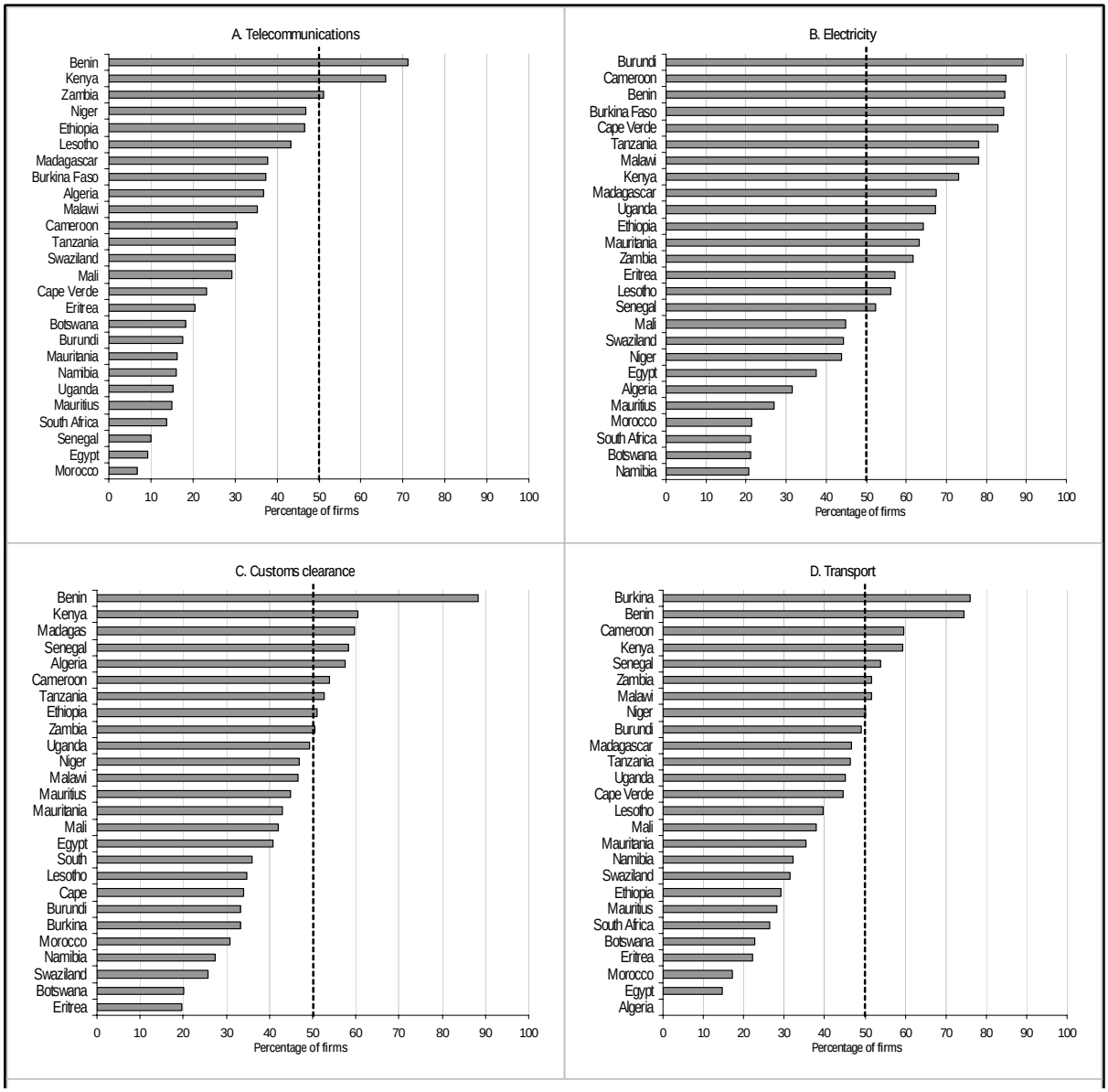
Figure 1.3 Evolution of per capita income in Africa relative to the United States, 1960–2003



Per capita income of country J (Y^J/P^J) is decomposed into the product of labor productivity (Y^J/L^J) and the labor participation rate (L^J/P^J) by: $(Y^J/P^J)= (Y^J/L^J)*(L^J/P^J)$. Therefore, per capita income relative to the United States becomes: $[(Y^J/P^J)/(Y^{US}/P^{US})]= [(Y^J/L^J)/(Y^{US}/L^{US})]*[(L^J/P^J)/ (L^{US}/P^{US})]$.

Source: Penn World Table, Center for International Comparisons of Production, Income and Prices at the University of Pennsylvania, 2006.

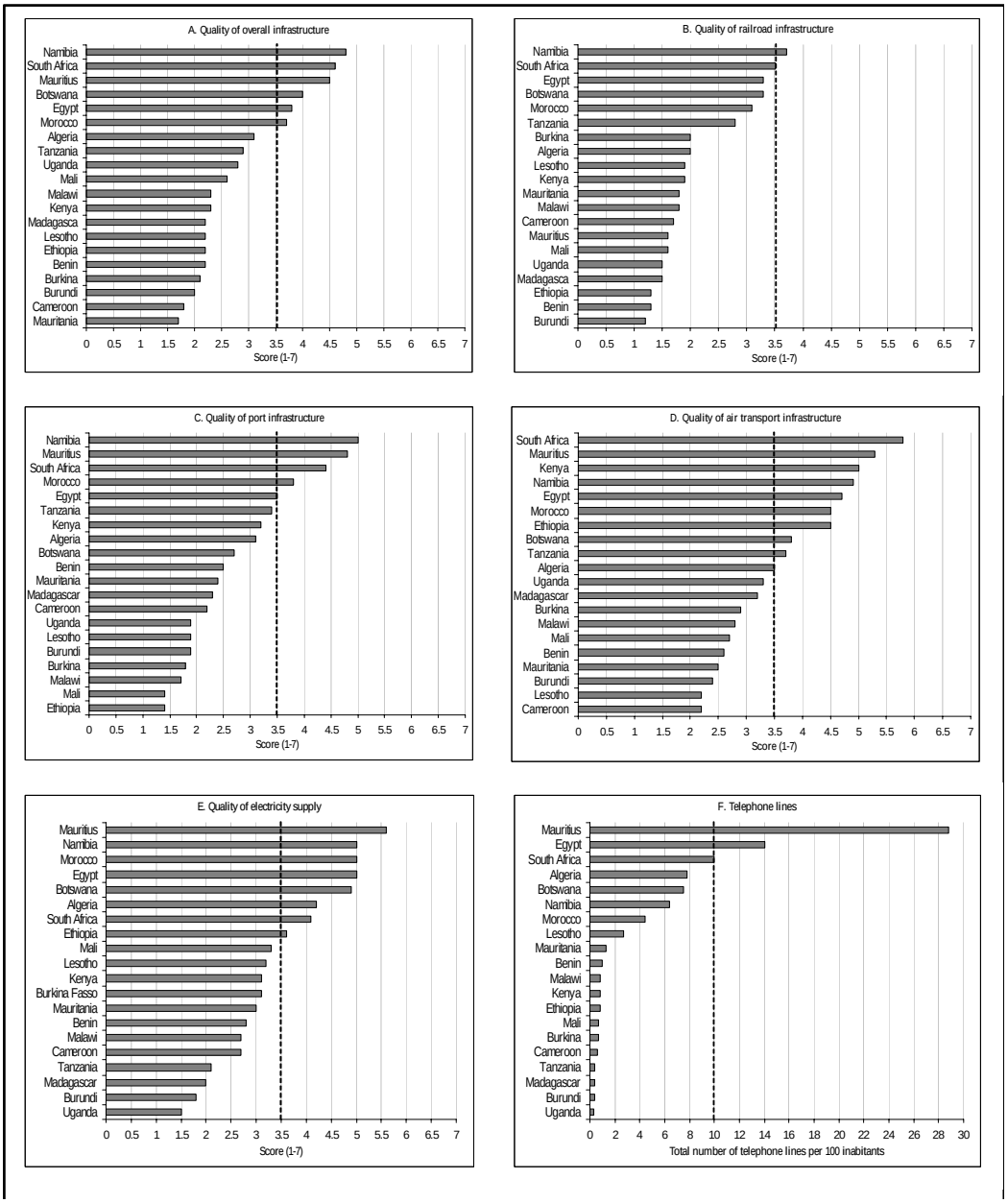
Figure 1.4 Percentage of firms that consider telecommunications, electricity, customs, and transport as severe or very severe constraints on economic performance (by country)



Source: Authors' calculations based on IC data.

Note: No data are available for perceptions of transport in Algeria.

Figure 1.5 The state of infrastructure in Africa, at first glance

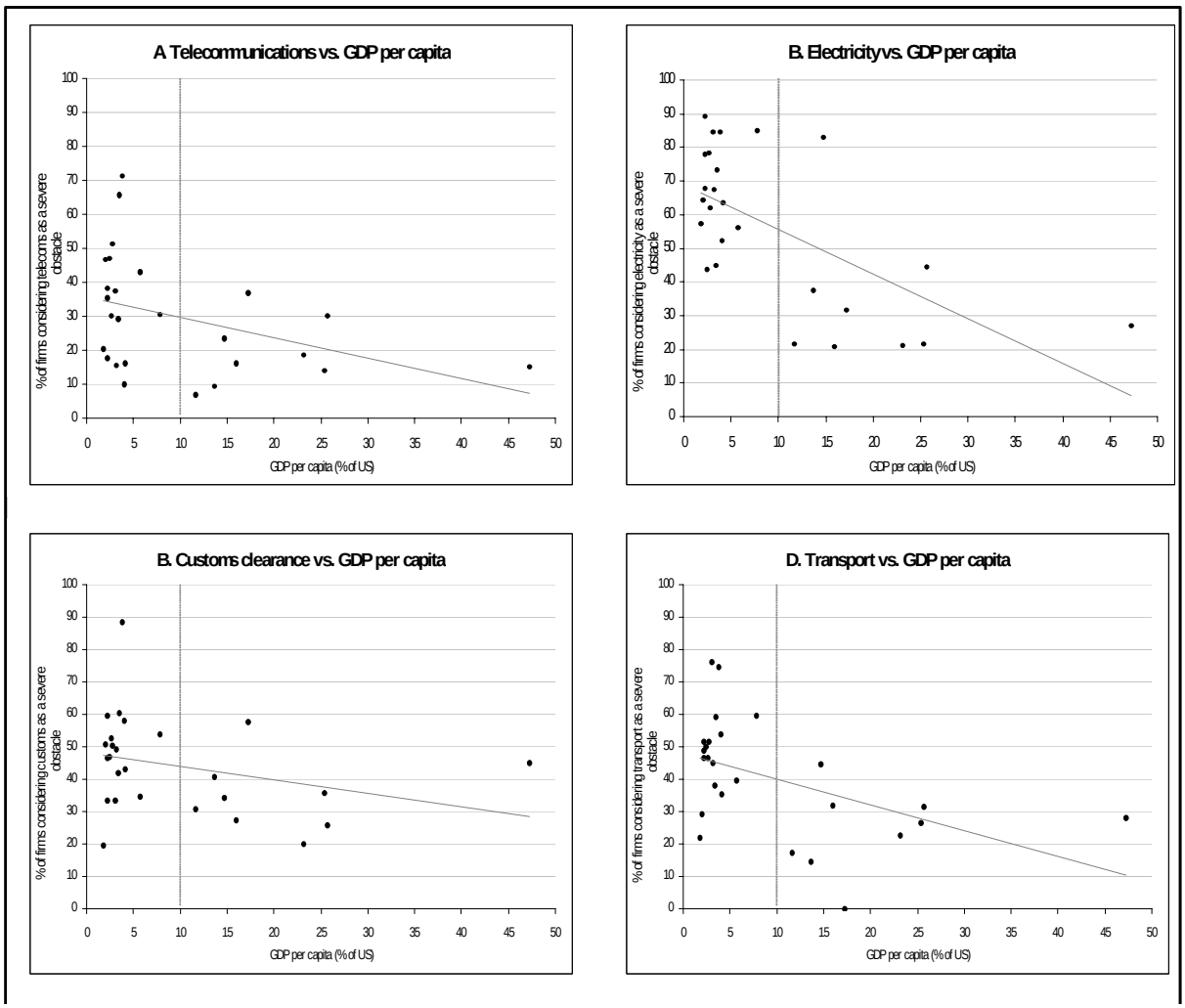


Source: Africa Competitiveness Report (2007), World Bank, Washington, DC.

Note: No data are available for Cape Verde, Eritrea, Niger, Senegal, Swaziland, or Zambia.

Figure 1.6 A simple illustration (cross-plots) of the relation between per capita GDP and infrastructure perceptions of severe or very severe obstacles to growth in Africa

GDP per capita relative to United States

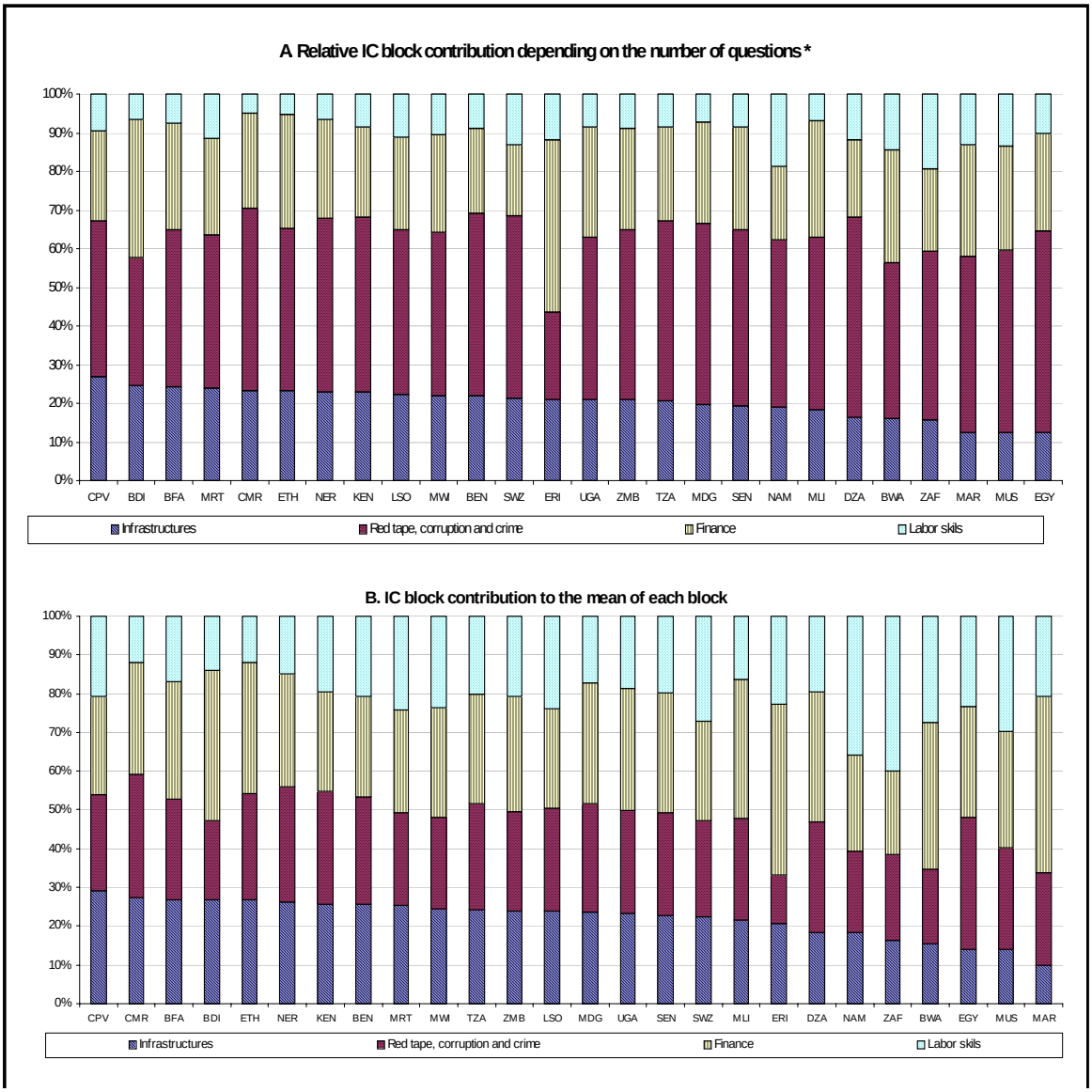


Source: Authors' calculations based on IC data.

Note: No data are available on perceptions of transport in Algeria.

Figures from section 5

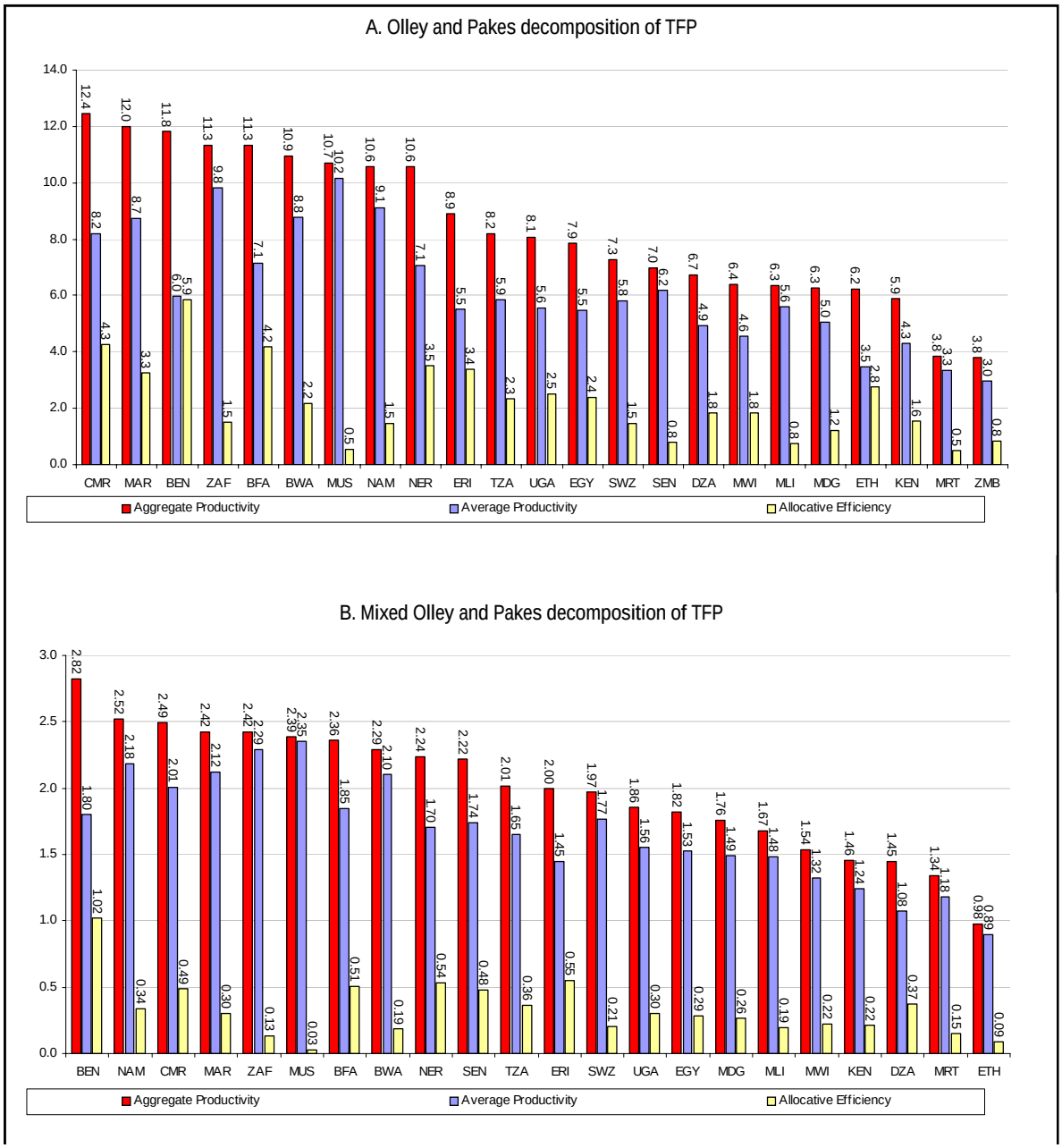
Figure 5.1 Rankings of firms' perceptions of severe and very severe obstacles to growth



Source: Authors' calculations from IC data.

Note: * = Number of questions on perceptions by blocks of IC variables: Infrastructure, 4 questions; red tape, corruption, and crime, 9 questions; finance and corporate governance, 2 questions; labor skills, 2 questions.

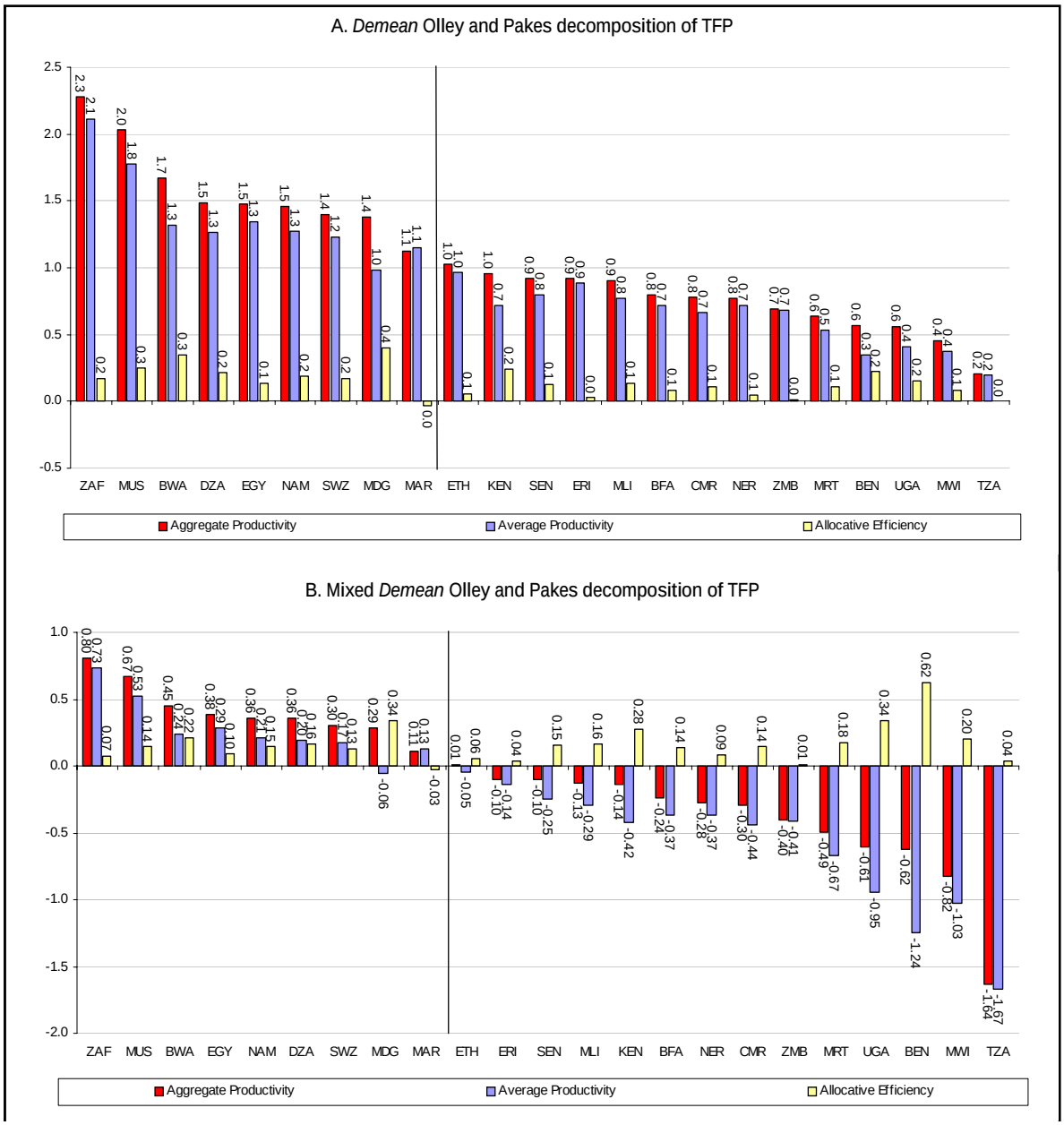
Figure 5.2 Olley and Pakes (O&P) decompositions of total factor productivity (TFP)



Source: Authors' calculations from IC data.

Notes: The Olley and Pakes (O&P) decomposition of TFP in levels is obtained from equation 4.4a of section 4. The mixed O&P decomposition is obtained from equation 4.4b. Sales in levels are used to compute the share of sales in both O&P decompositions.

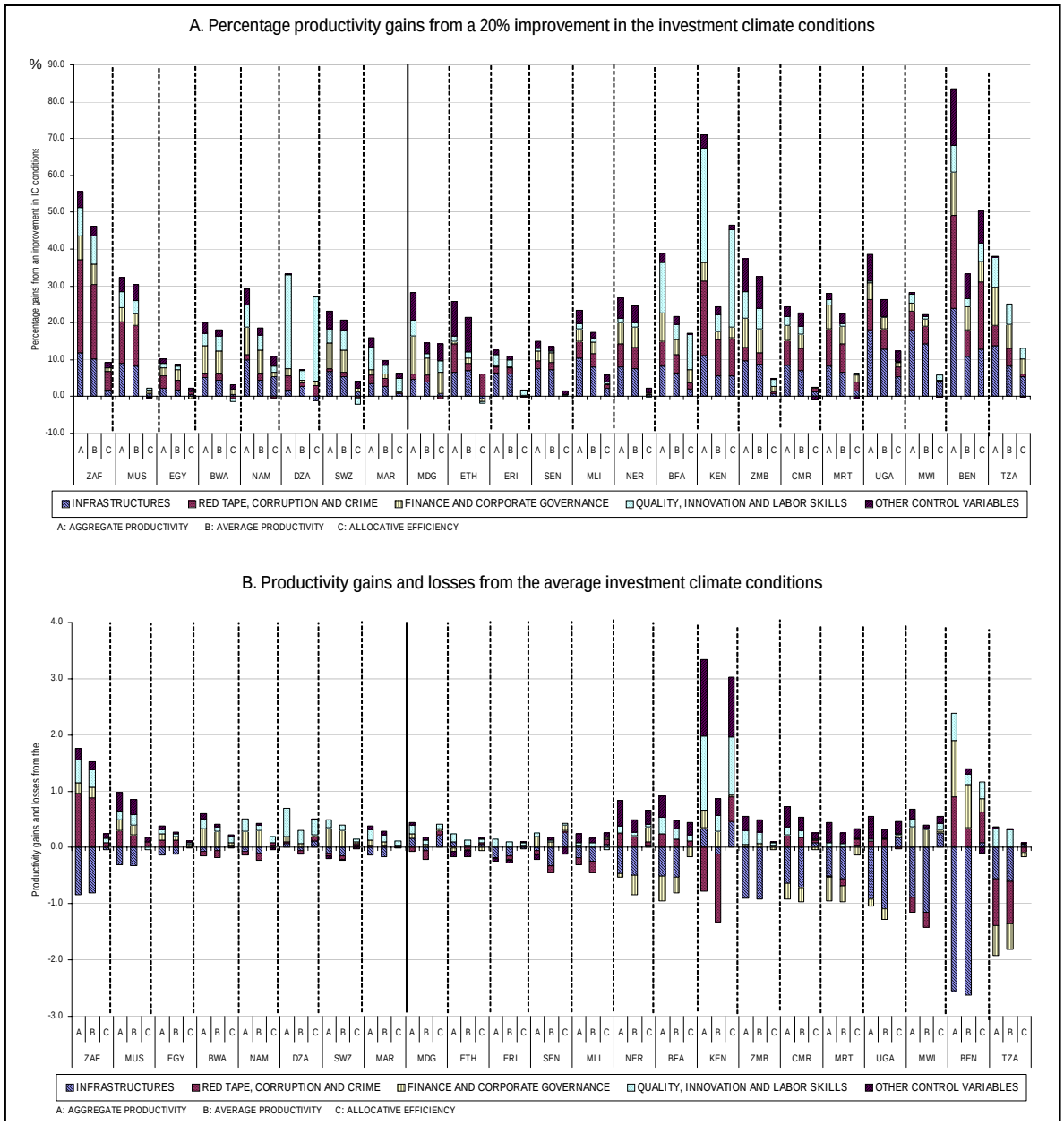
Figure 5.3 Demeaned O&P decompositions of TFP



Source: Authors' calculations from IC data.

Notes: The demeaned Olley and Pakes (O&P) decomposition of TFP in levels is given by equation 4.7. It is derived from equation 4.4a, using as the productivity measure the demeaned counterpart of the restricted Solow residual (see equation 4.3b) in levels. The demeaned mixed O&P decomposition comes from equation 4.4b, with the demeaned log-TFP of equation 4.3b in logs. Sales in levels are used to compute the share of sales in both O&P decompositions.

Figure 5.4 Demeaned productivity by groups of IC variables: simulations and average contributions

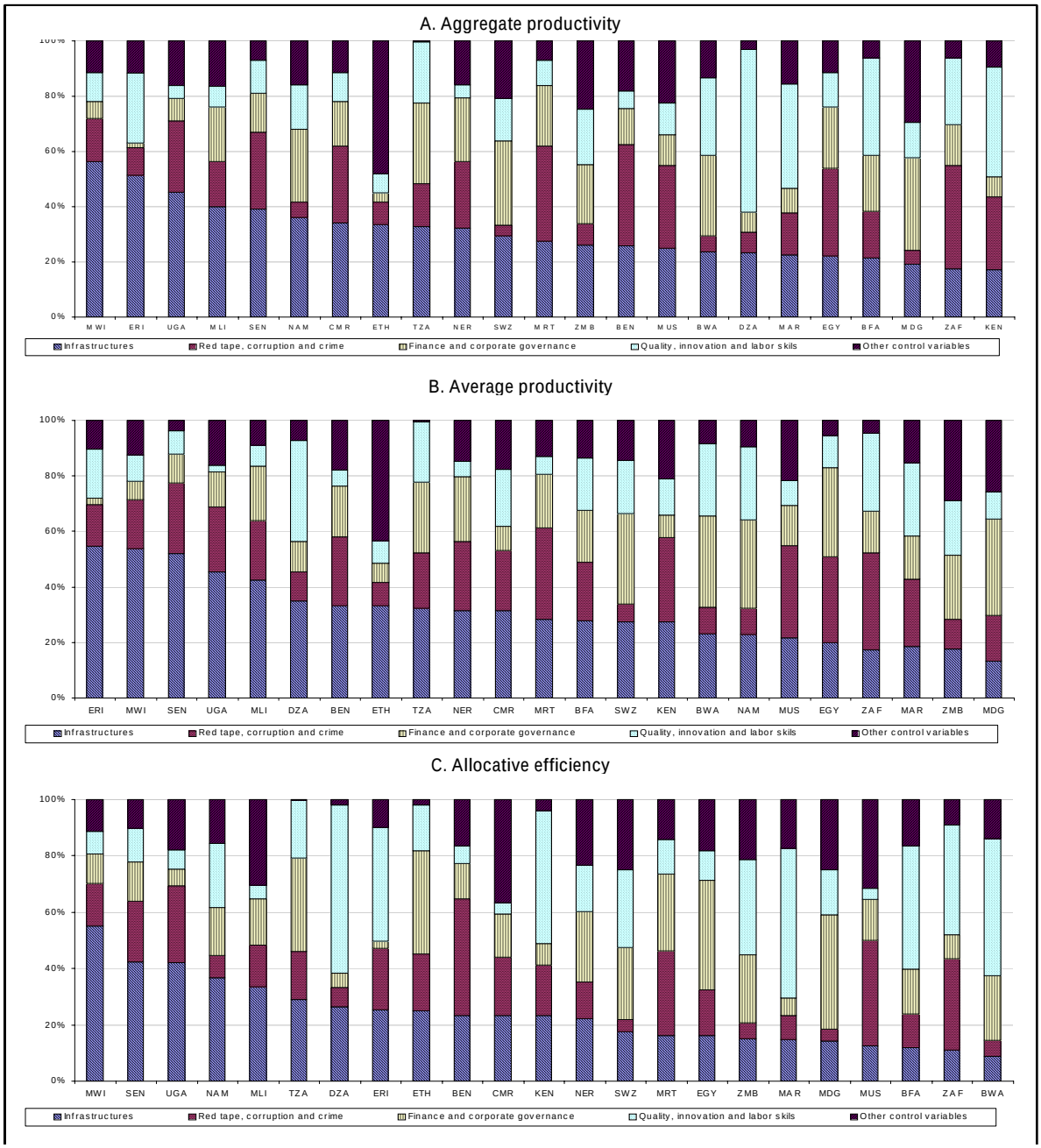


Source: Authors' calculations from IC data.

Note: The simulations are done variable by variable. The total percentage productivity gain from each group of variables (infrastructure; red tape, etc.) is computed as the sum of the individual productivity gains caused by the improvement in the IC variables of that group (one by one). Therefore, the final productivity gain should be interpreted in *ceteris paribus* terms: how much does productivity increase when the corresponding variable improves by 20 percent, holding everything else constant?

The productivity gains and losses from the average investment climate come from the decomposition of the demeaned Olley & Pakes decomposition in logs by groups of variables (4.8). The productivity gain or loss from the infrastructure group for each country is computed as the sum of the percentage contributions to average log-TFP caused by the average individual infrastructure variables. The same holds for the rest of the groups of IC and C variables.

Figure 5.5 Simulation of infrastructure absolute effects on productivity (20 percent improvement)



Source: Authors' calculations from IC data.

Note: The percentage contribution of the infrastructure group is computed as the sum of the absolute values of the percentage contributions of the individual infrastructure variables, divided by the cumulative sum in absolute terms of the percentage contributions of all the IC and C variables, including infrastructure. The holds for the rest of the IC blocks of variables.

Figure 5.6 Infrastructure absolute effects on productivity: Mixed *demeaned* O&P decomposition

Source: Authors' calculations from IC data.

Note: The percentage contribution of the infrastructure group is computed as the sum of the absolute values of the percentage contributions of the individual infrastructure variables, divided by the cumulative sum in absolute terms of the percentage contributions of all the IC and C variables, including infrastructure. The holds for the rest of the IC blocks of variables.

Figure 5.7. Cross-plot between demeaned aggregate productivity and GDP per capita (% of US)

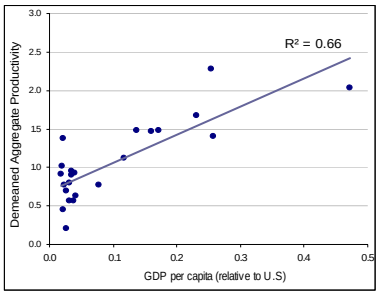


Figure 5.8. Cross-plot between demeaned aggregate productivity and ranking on the ease of doing business*

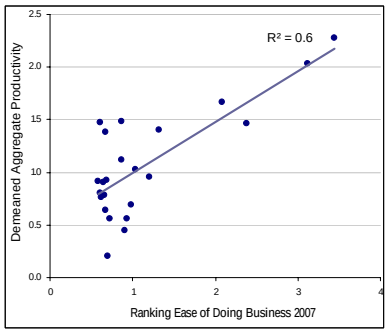
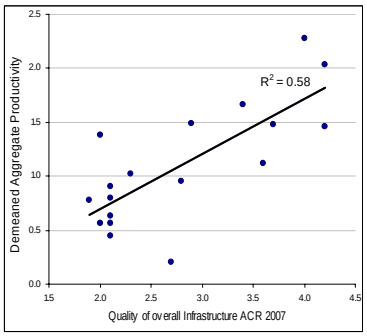


Figure 5.9. Cross-plot between demeaned aggregate productivity and quality of overall infrastructure from ACR 2007*



*Rank is computed as: (total number of firms in DBR-Rank)/ total number of firms in DBR
Source: Authors´ calculations with IC data, Doing Business Report (2007) and Penn World Table.

Figure 5.10. Cross-plot between demeaned aggregate productivity and firms´ perceptions on infrastructure as an obstacle

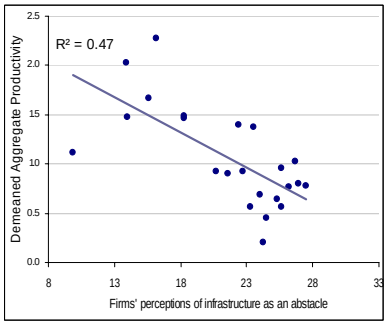


Figure 5.11. Cross-plot between demeaned aggregate productivity and percentage absolute contribution of infrastructure to average log-productivity

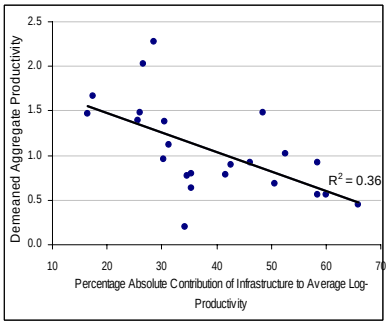
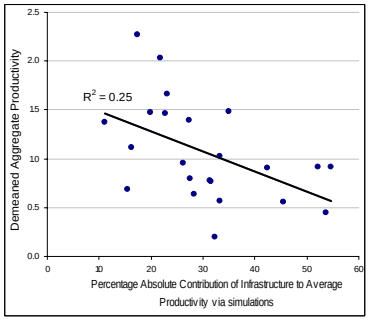


Figure 5.12. Cross-plot between demeaned aggregate productivity and percentage absolute contribution of infrastructure to average productivity via simulations



Source: Authors´ calculations with IC data.

Figure 5.13. Cross-plot between demeaned aggregate productivity and percentage absolute contributions of infrastructure to allocative efficiency (TFP in logs)

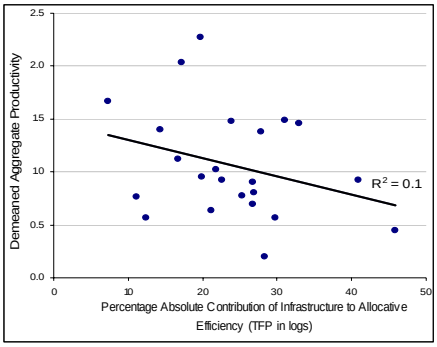


Figure 5.14. Cross-plot between demeaned aggregate productivity and percentage absolute contributions of infrastructure to allocative efficiency via simulations

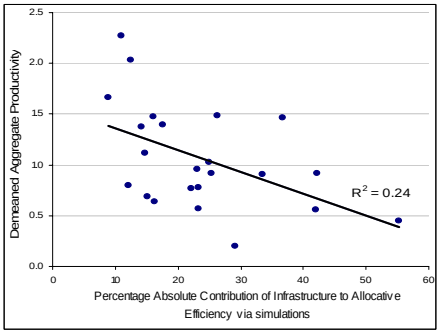


Figure 5.15. Cross-plot between percentage absolute contribution to average log–productivity and contributions via simulations

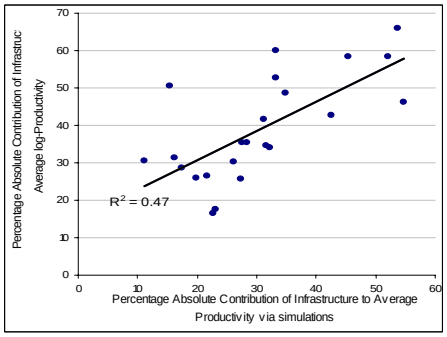
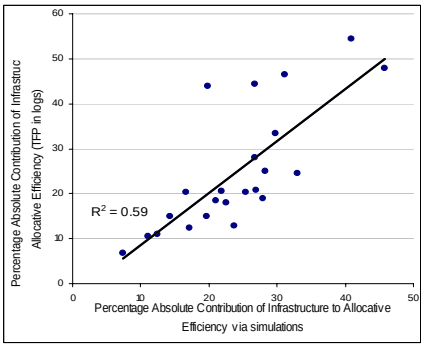


Figure 5.16. Cross-plot between percentage absolute contribution to allocative efficiency (with TFP in logs) and contributions via simulations



Source: Authors' calculations with IC data.

Figures from section 6

Figure 6.1 Impact of infrastructure on productivity in Algeria

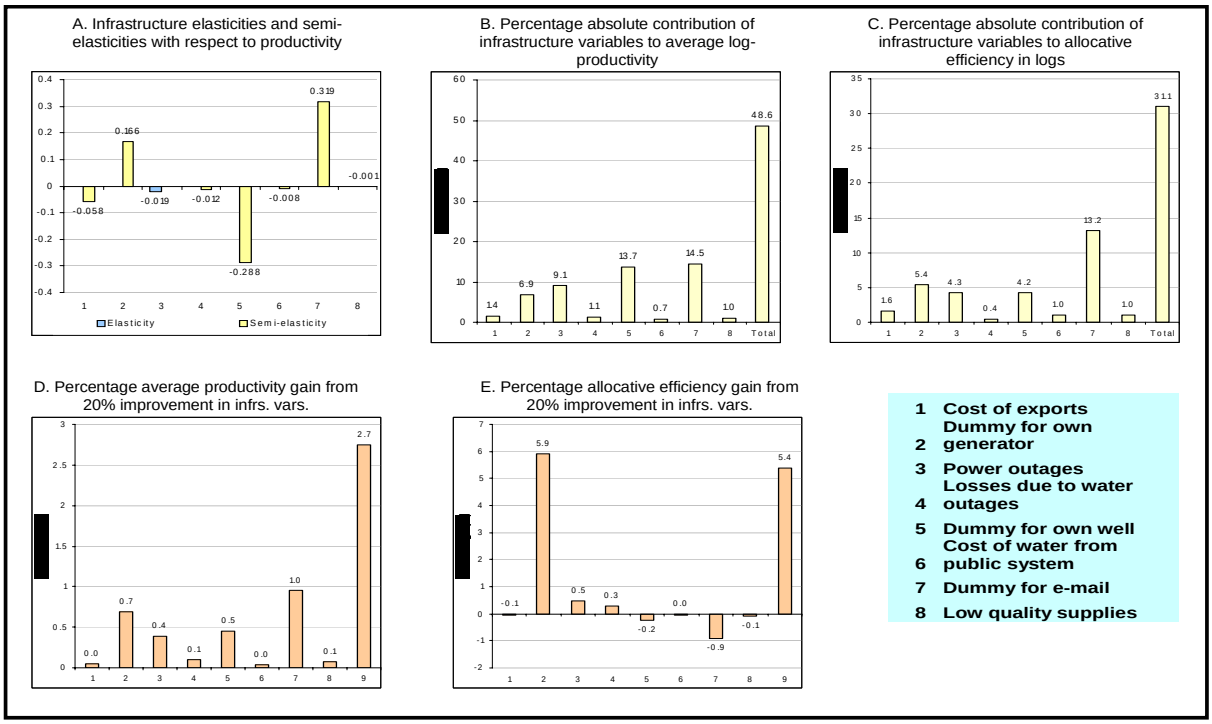


Figure 6.2 Impact of infrastructure on productivity in Benin

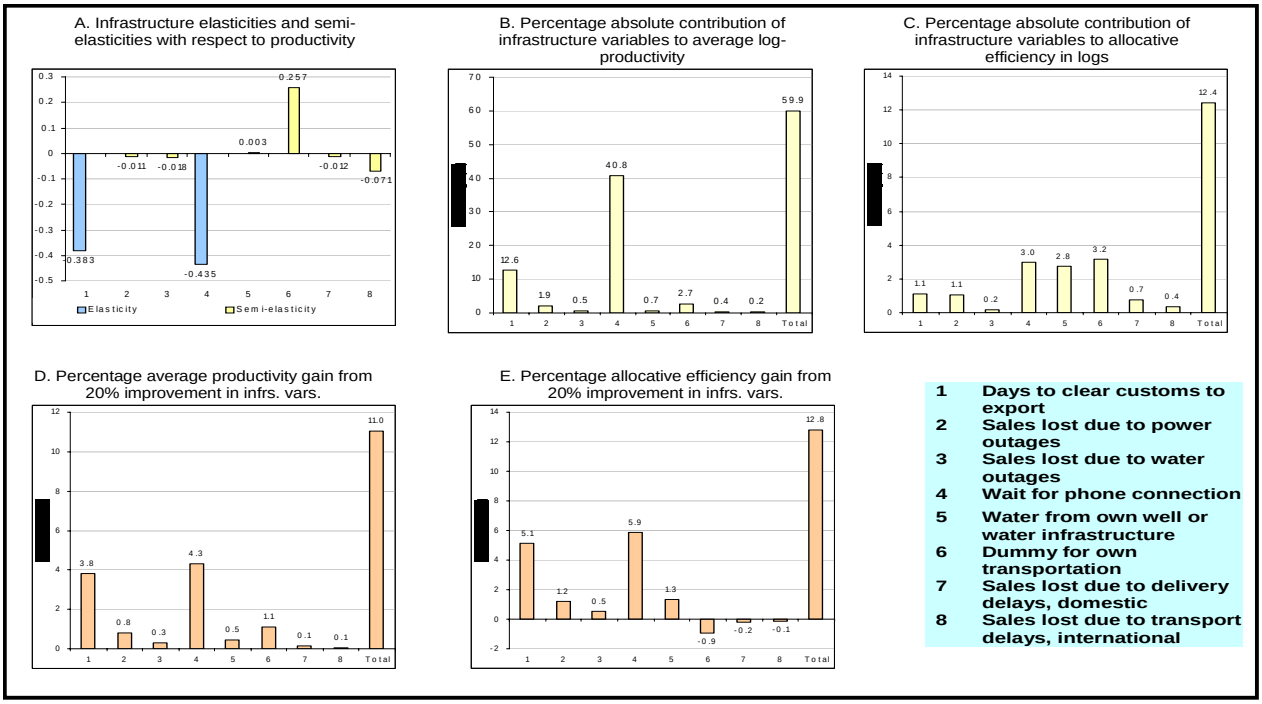


Figure 6.3 Impact of infrastructure on productivity in Botswana

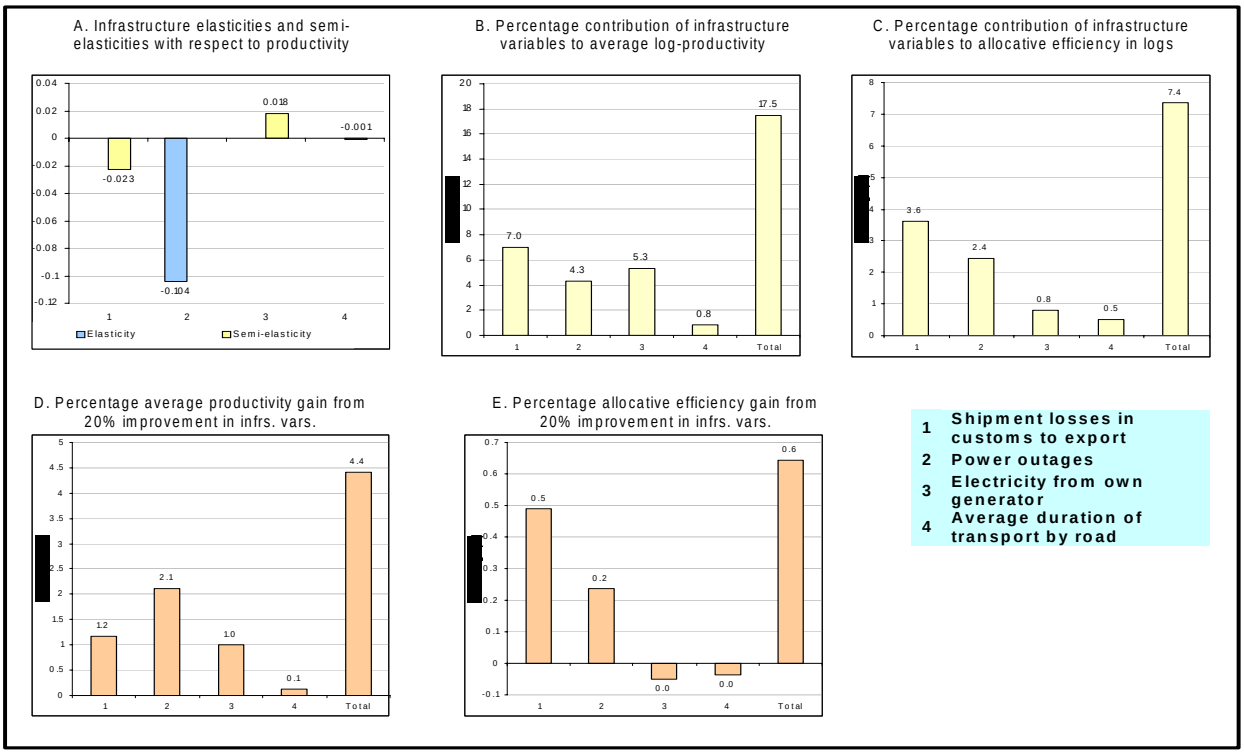


Figure 6.4 Impact of infrastructure on productivity in Burkina Faso

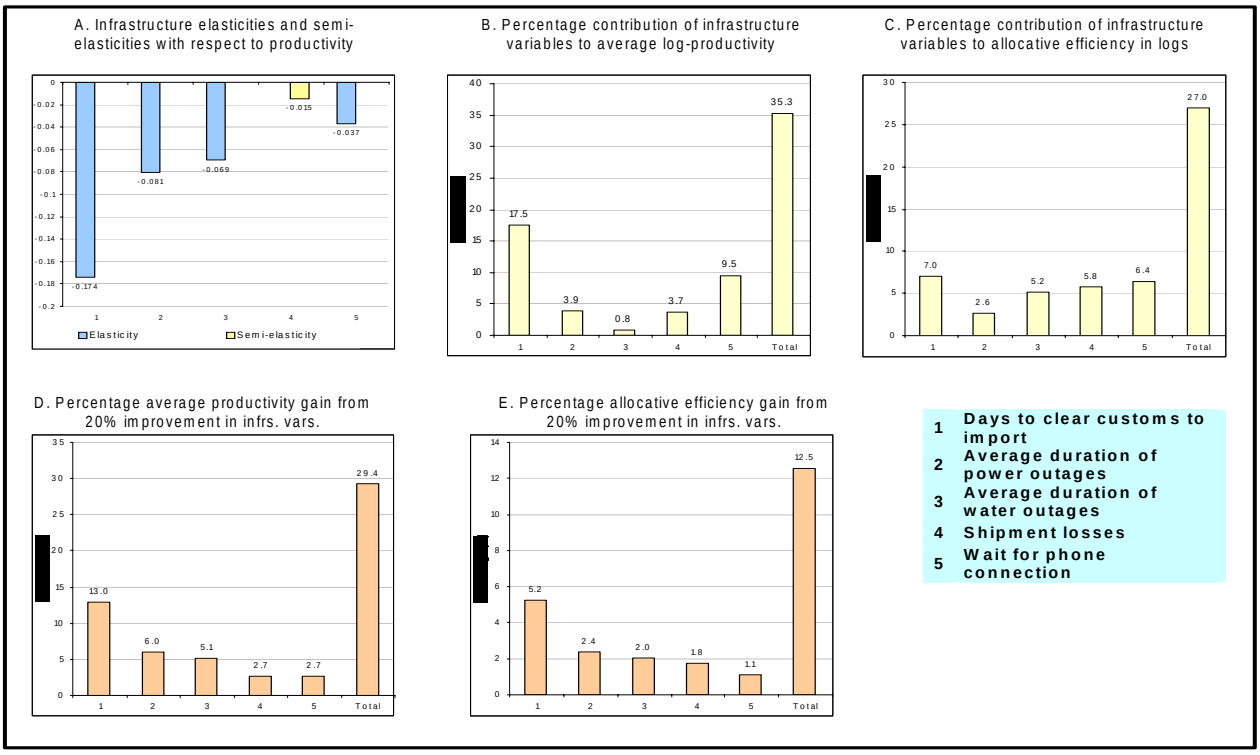


Figure 6.5 Impact of infrastructure on productivity in Cameroon

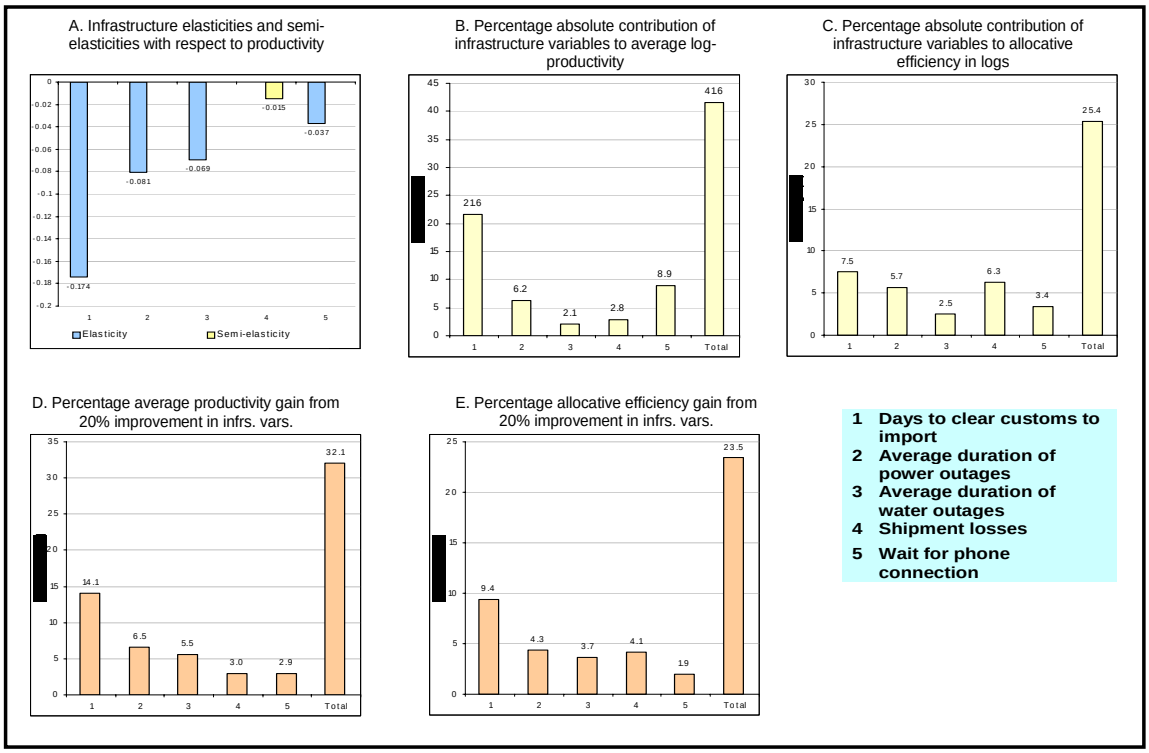


Figure 6.6 Impact of infrastructure on productivity in Egypt

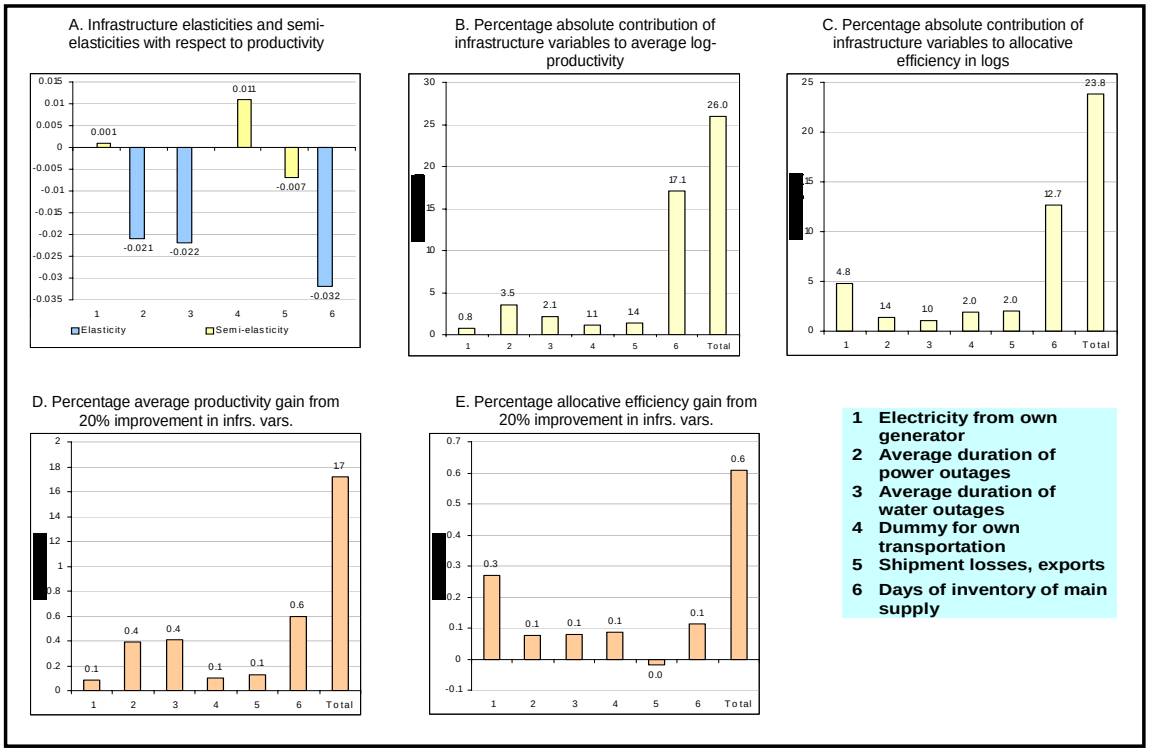


Figure 6.7 Impact of infrastructure on productivity in Eritrea

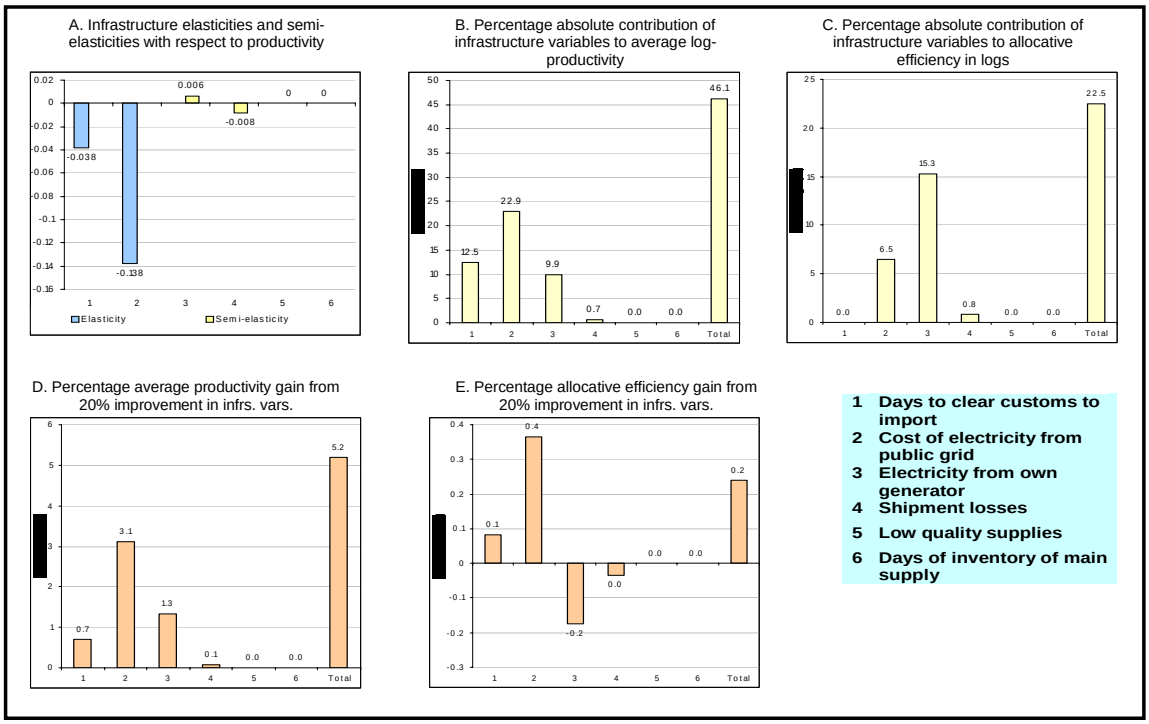


Figure 6.8 Impact of infrastructure on productivity in Ethiopia

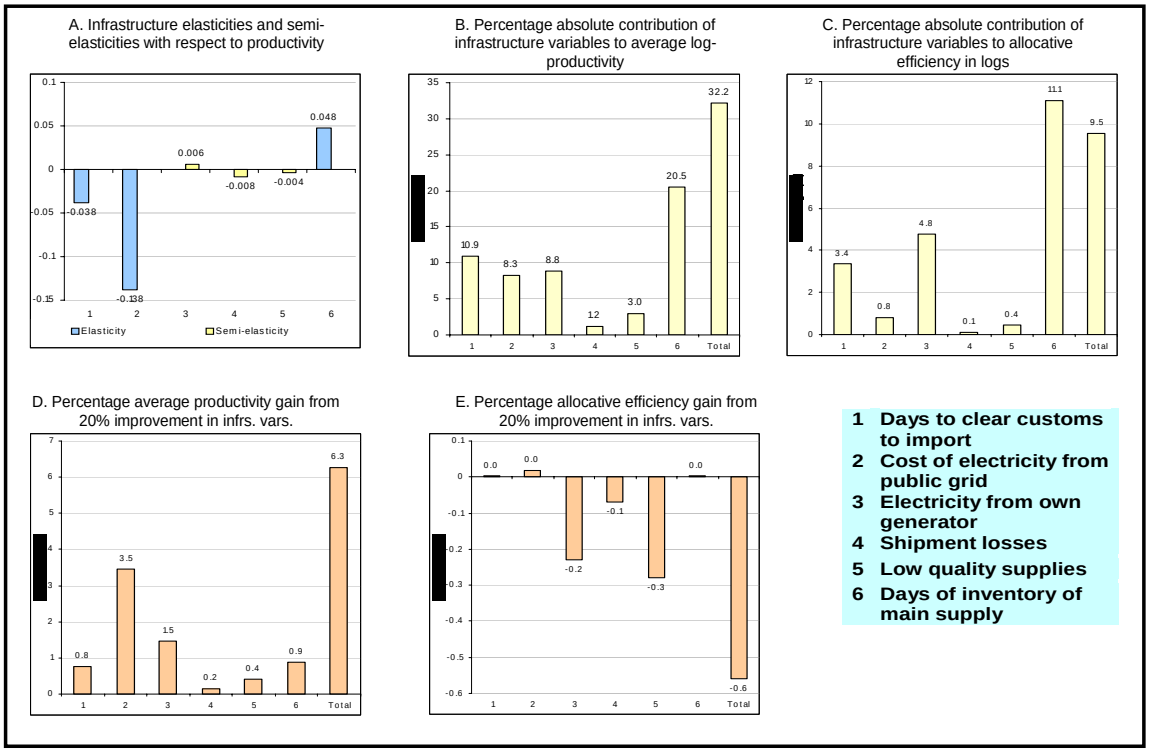


Figure 6.9 Impact of infrastructure on productivity in Kenya

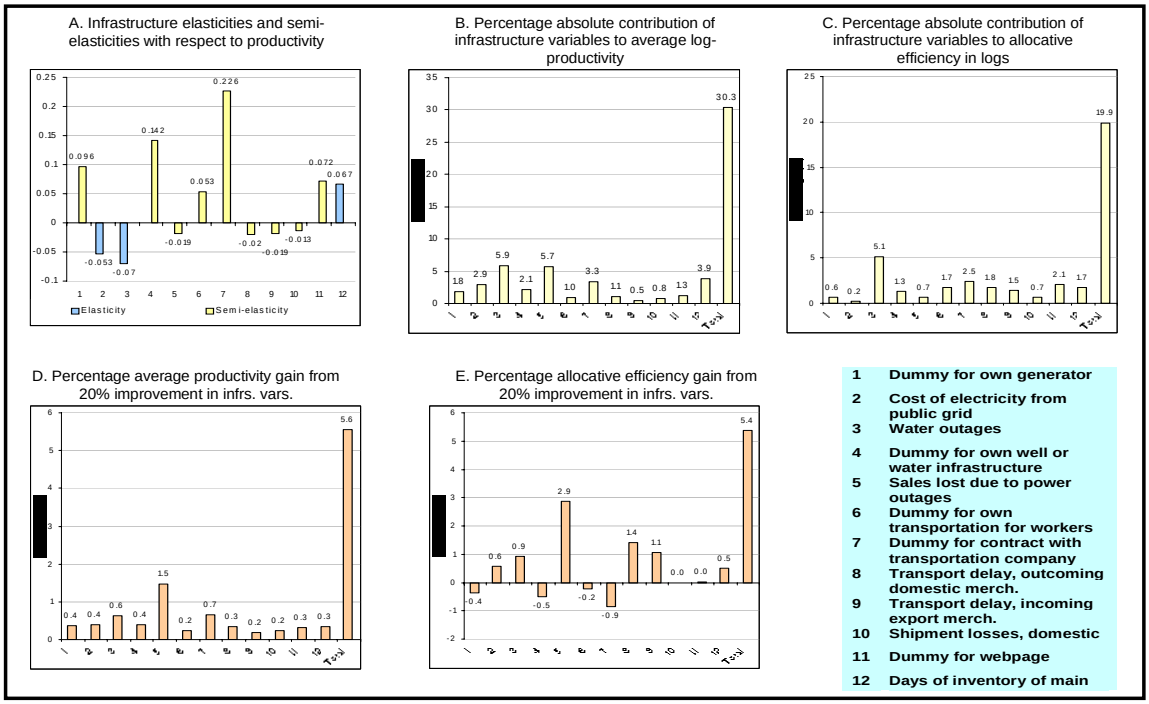


Figure 6.10 Impact of infrastructure on productivity in Madagascar

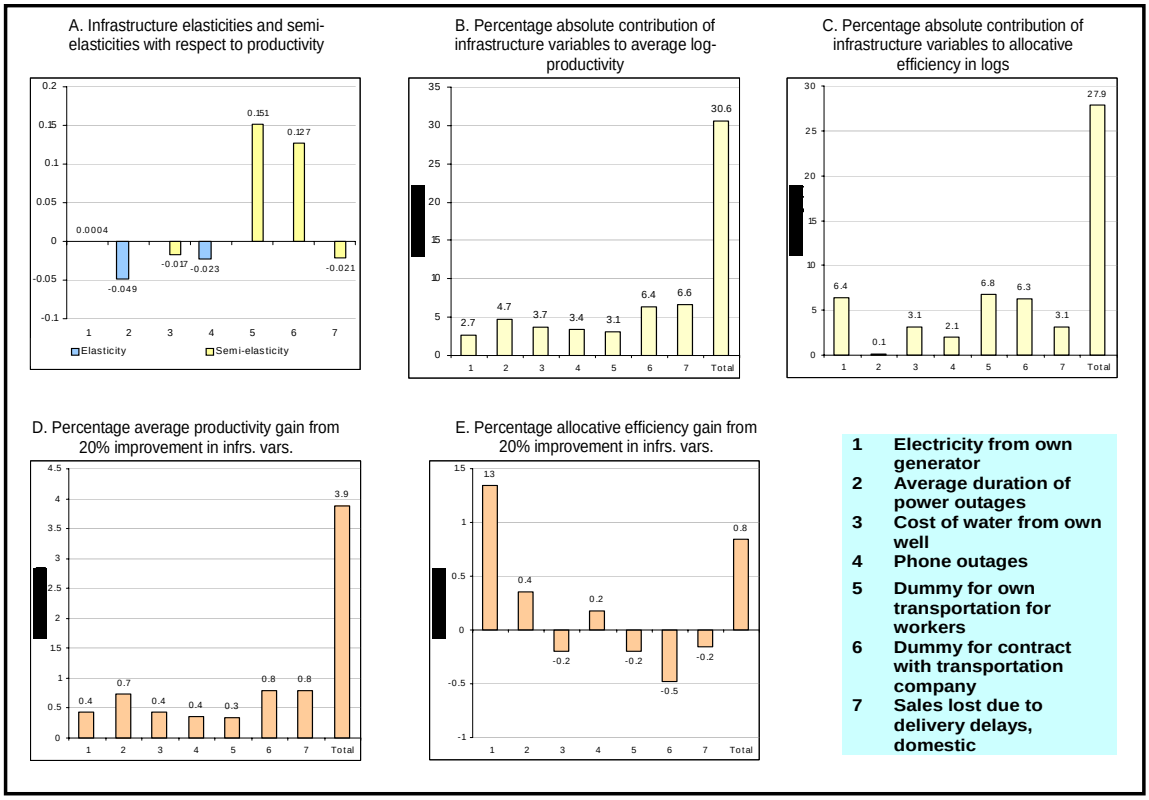


Figure 6.11 Impact of infrastructure on productivity in Malawi

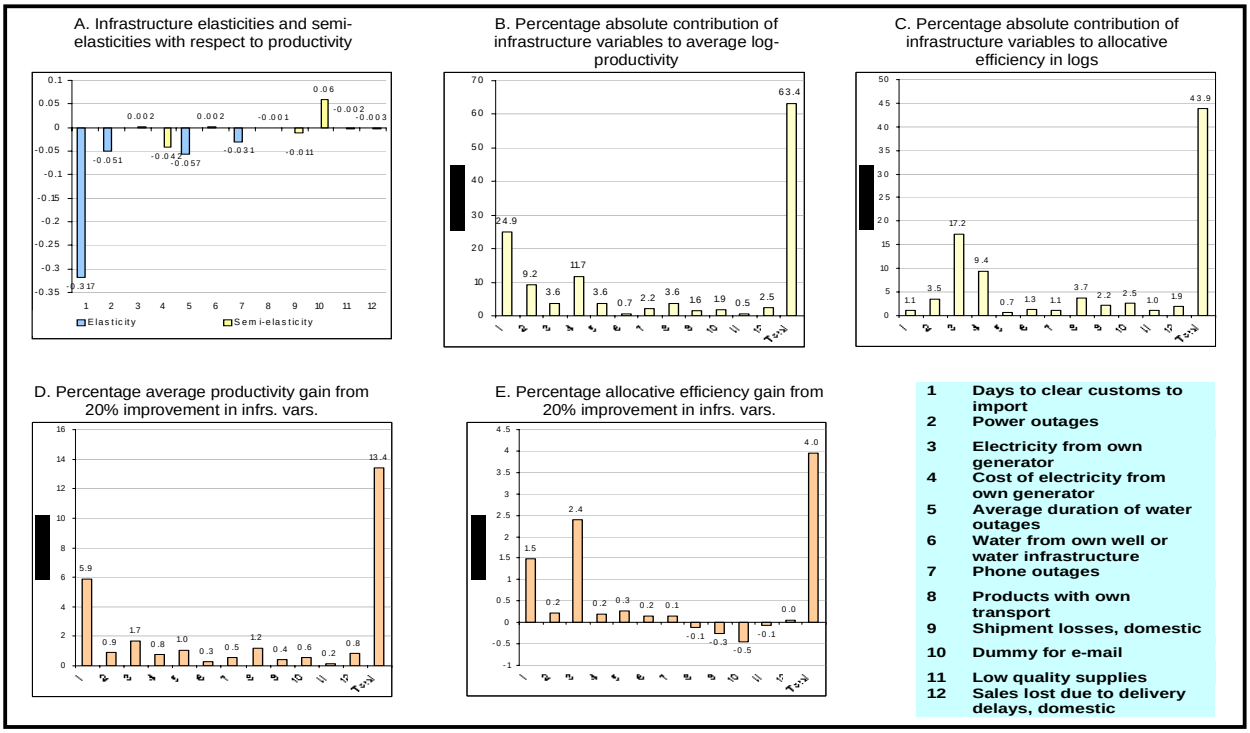


Figure 6.12 Impact of infrastructure on productivity in Mali

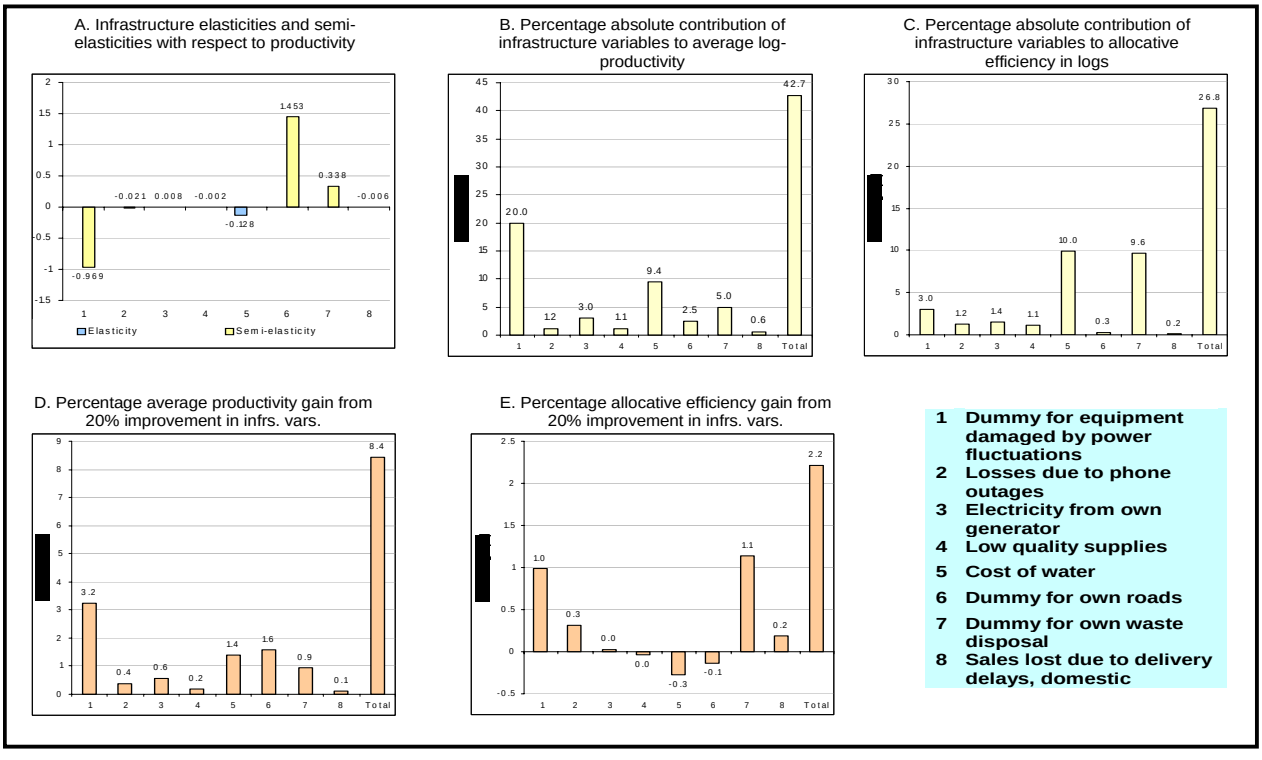


Figure 6.13 Impact of infrastructure on productivity in Mauritania

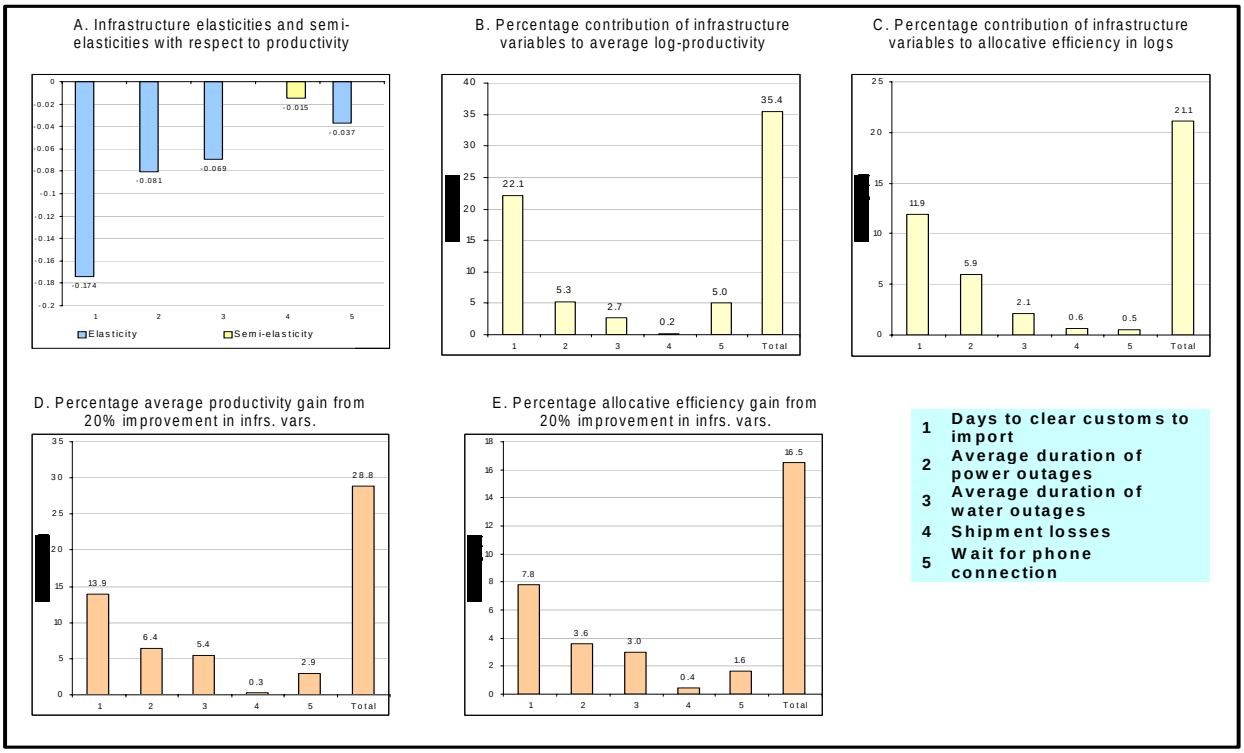


Figure 6.14 Impact of infrastructure on productivity in Mauritius

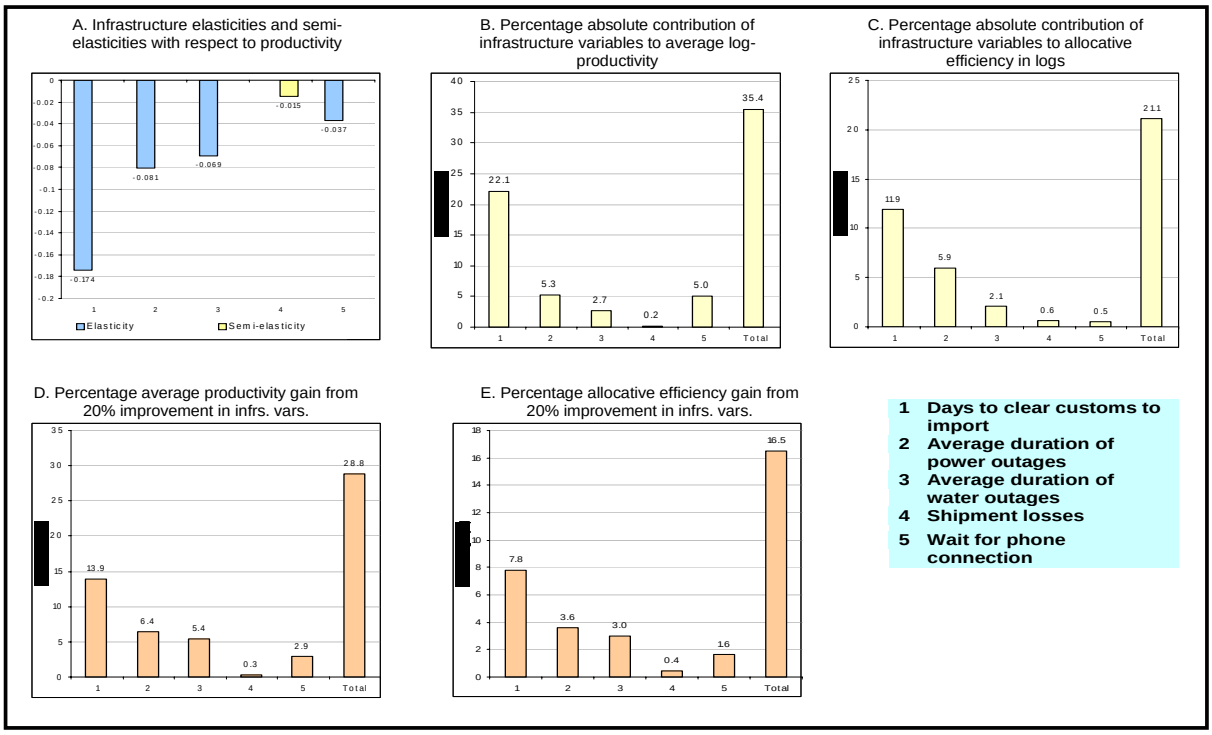


Figure 6.15 Impact of infrastructure on productivity in Morocco

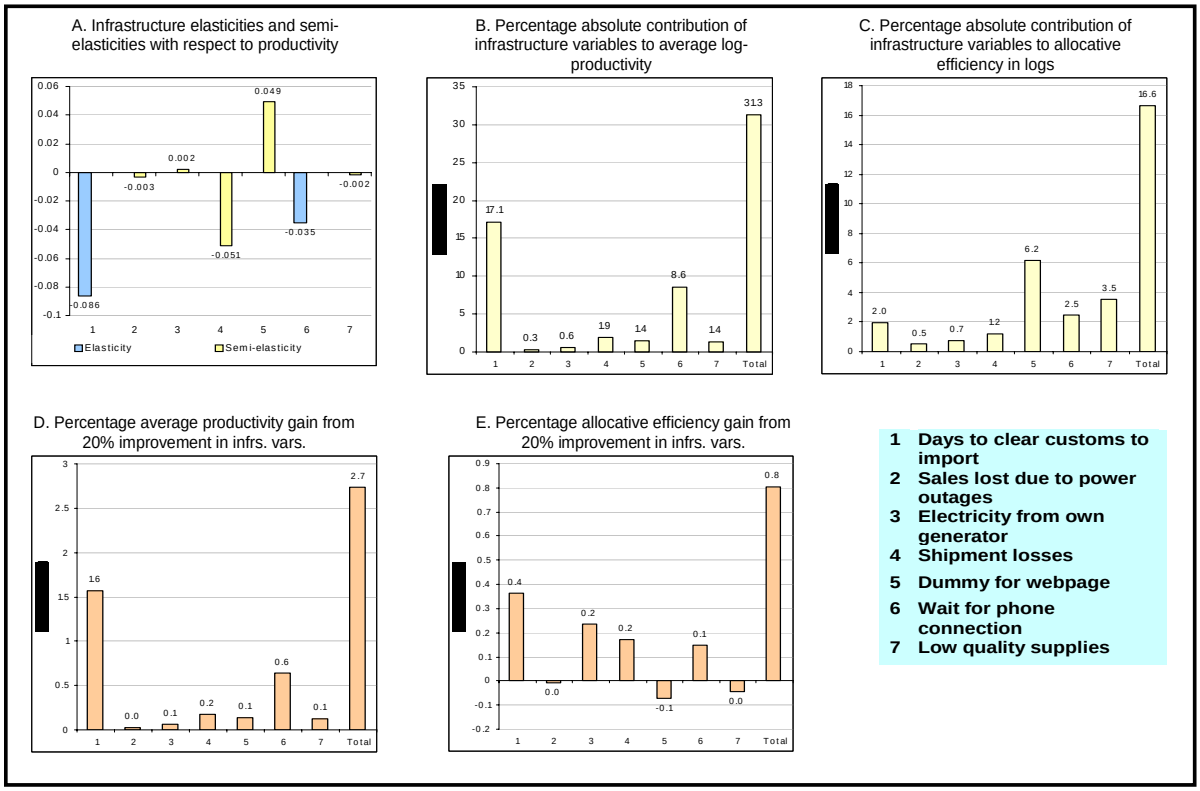


Figure 6.16 Impact of infrastructure on productivity in Namibia

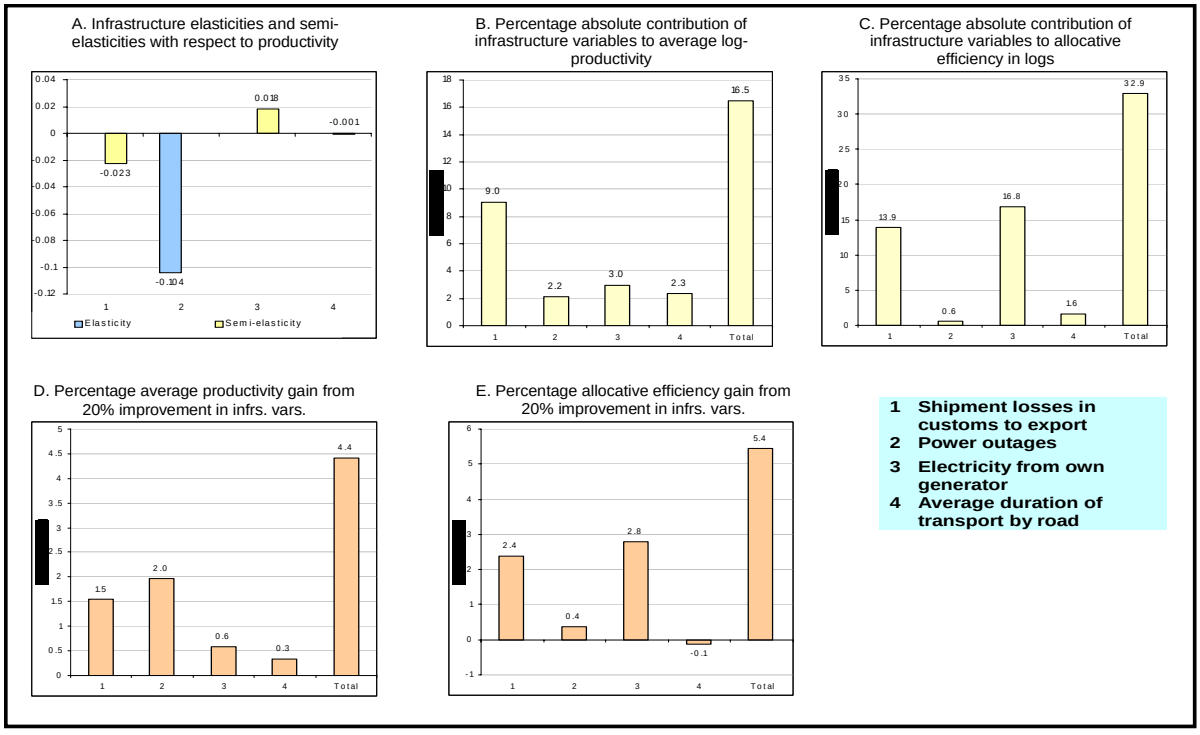


Figure 6.17 Impact of infrastructure on productivity in Niger

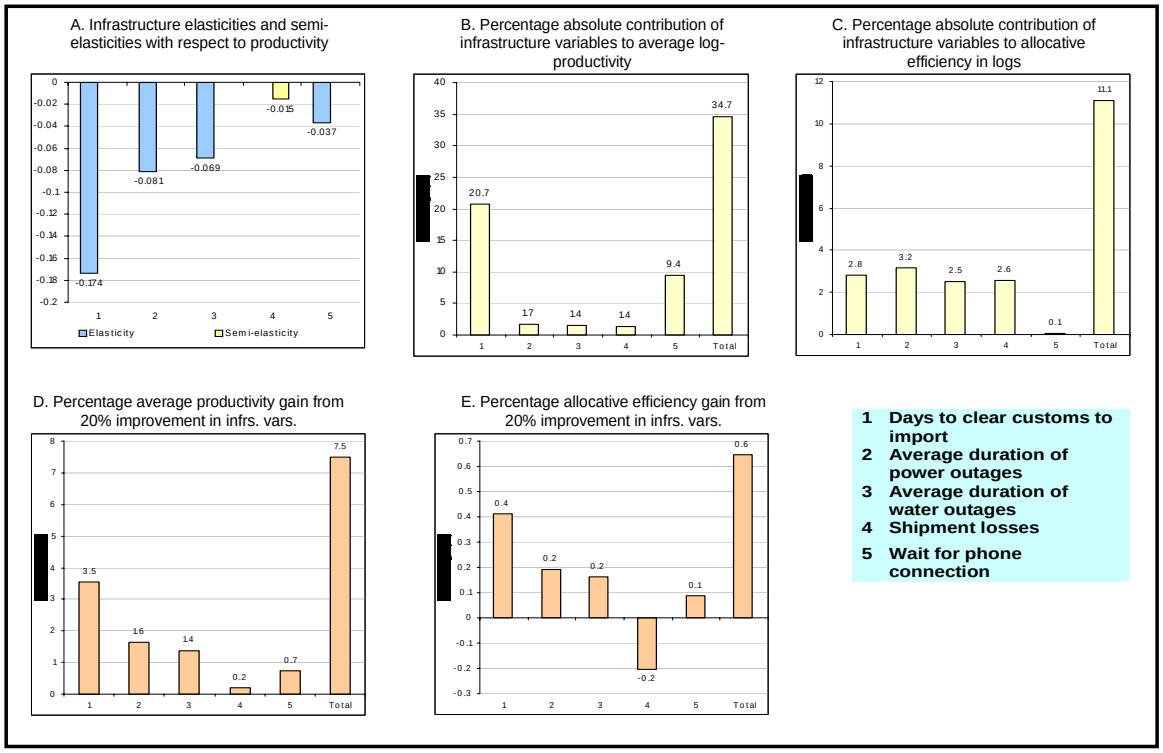


Figure 6.18 Impact of infrastructure on productivity in Senegal

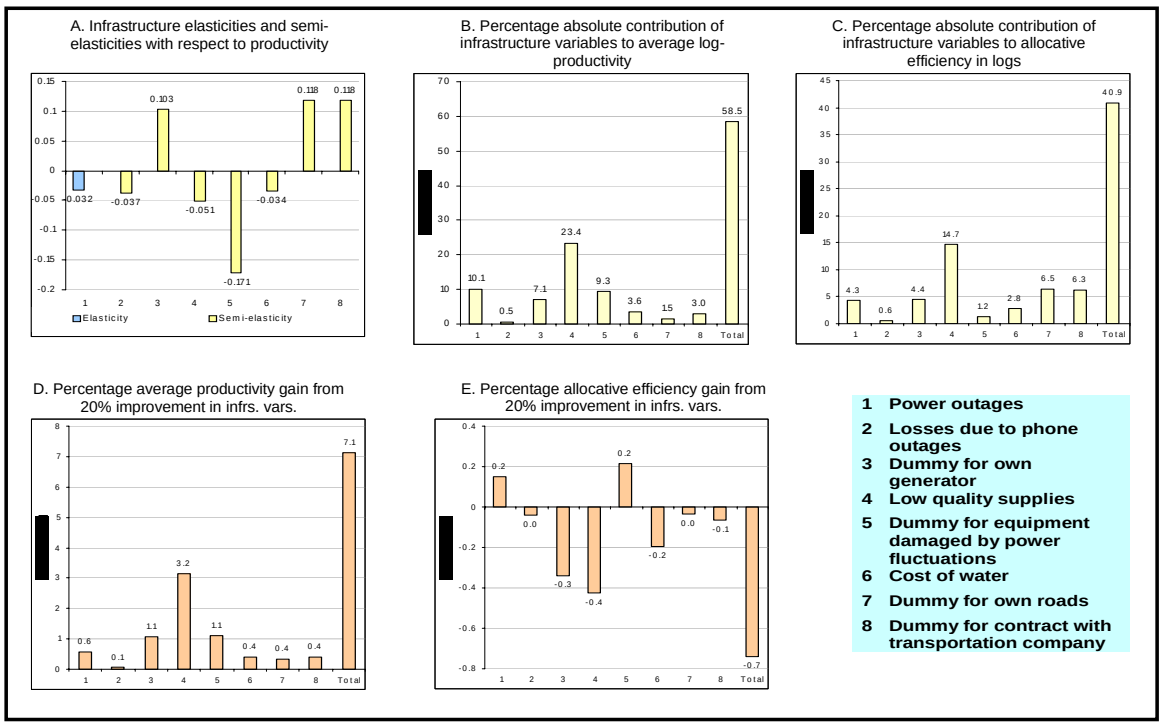


Figure 6.19 Impact of infrastructure on productivity in South Africa

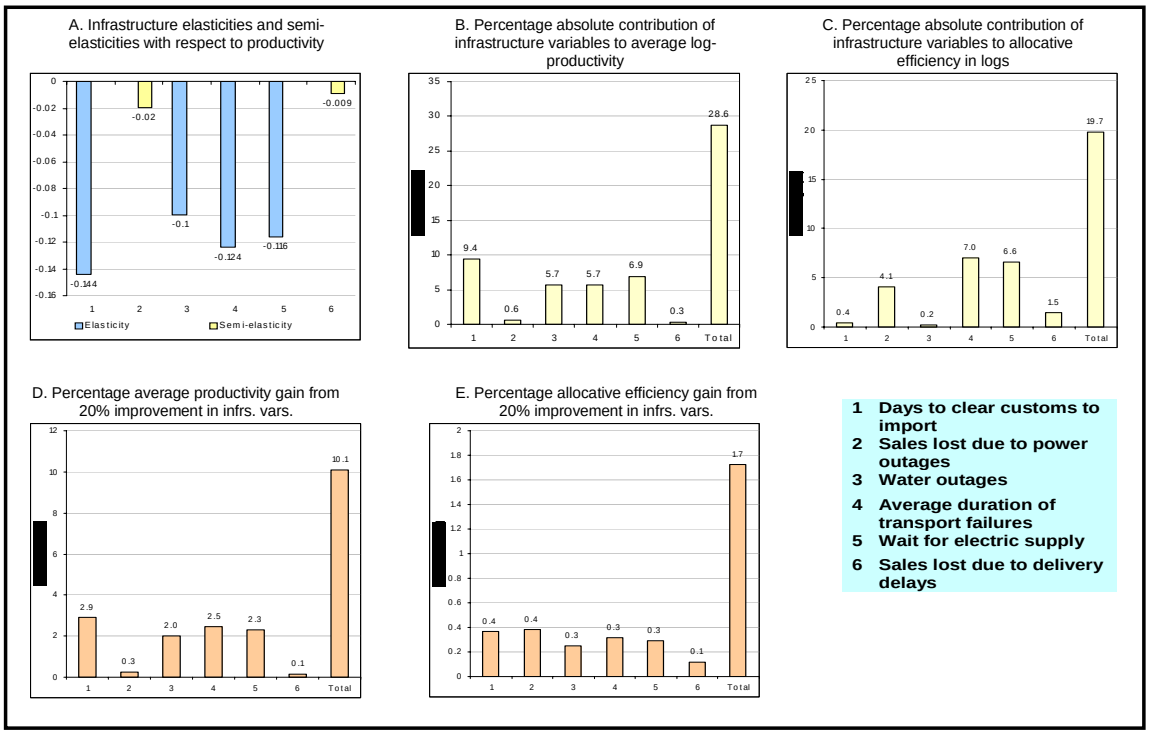


Figure 6.20 Impact of infrastructure on productivity in Swaziland

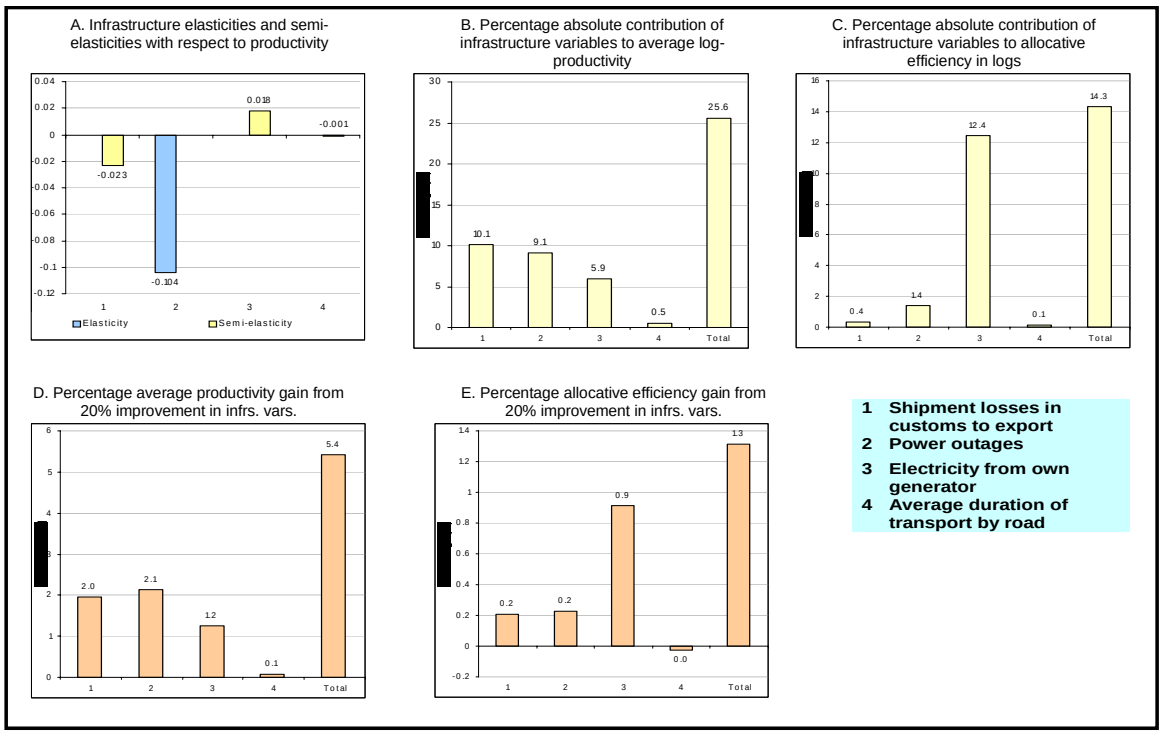


Figure 6.21 Impact of infrastructure on productivity in Tanzania

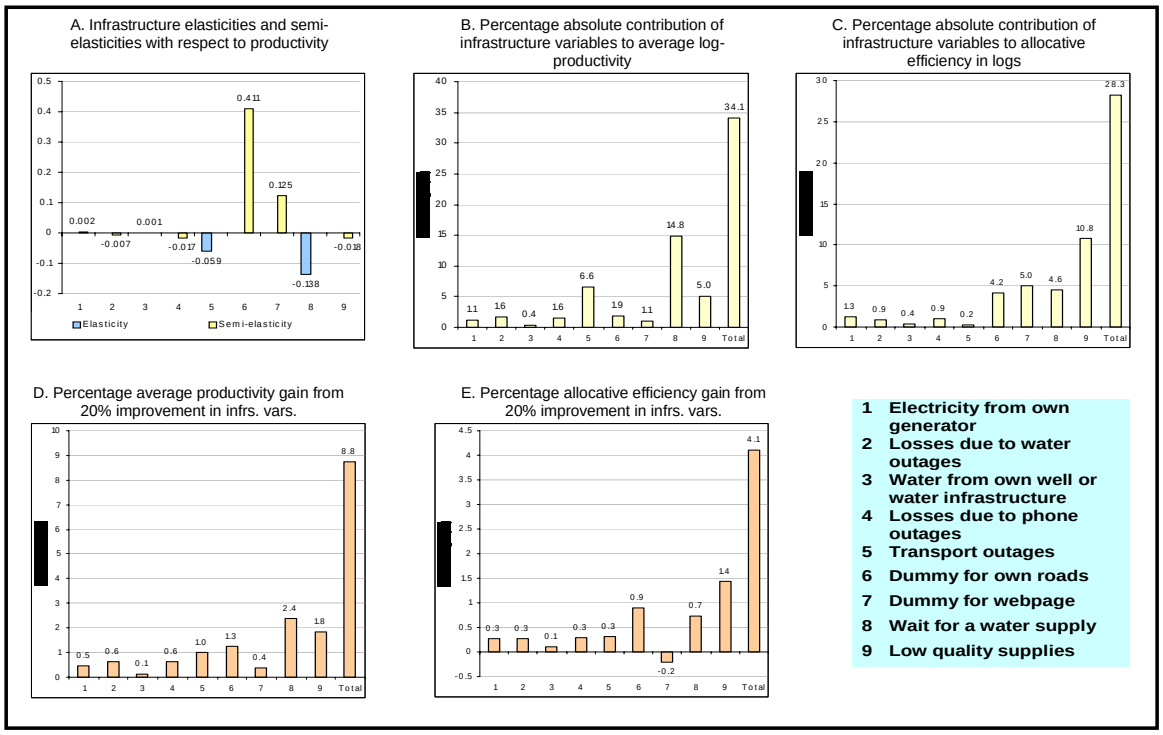


Figure 6.22 Impact of infrastructure on productivity in Uganda

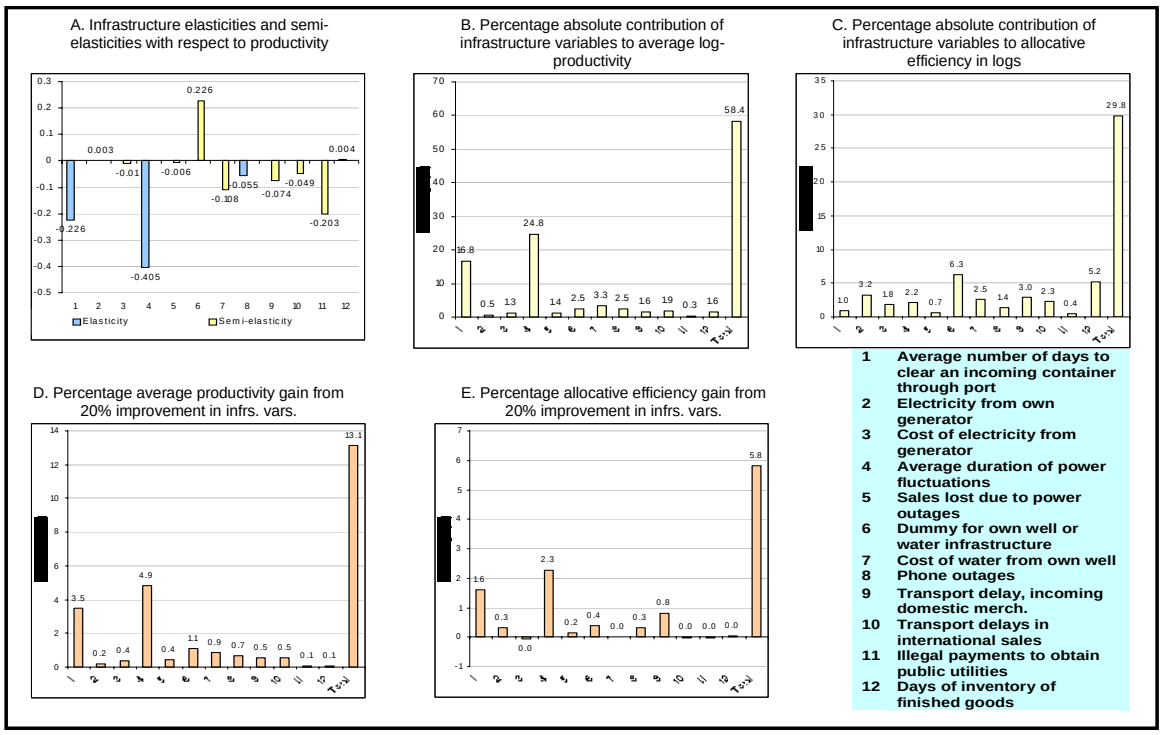


Figure 6.23 Impact of infrastructure on productivity in Zambia

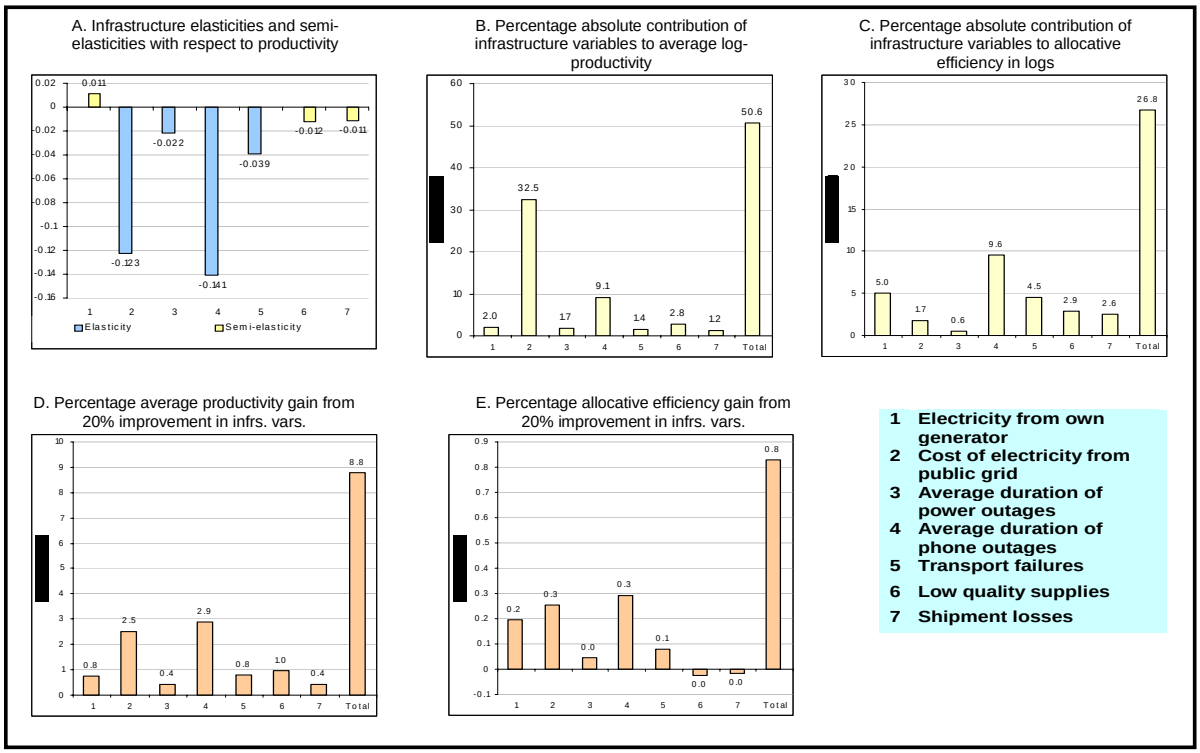
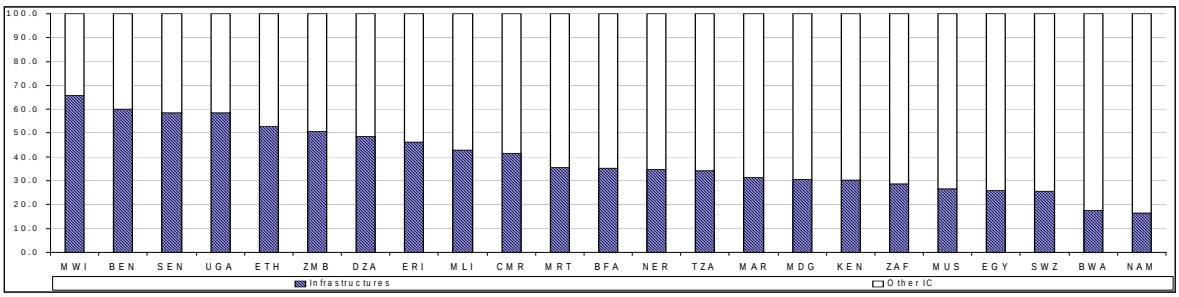
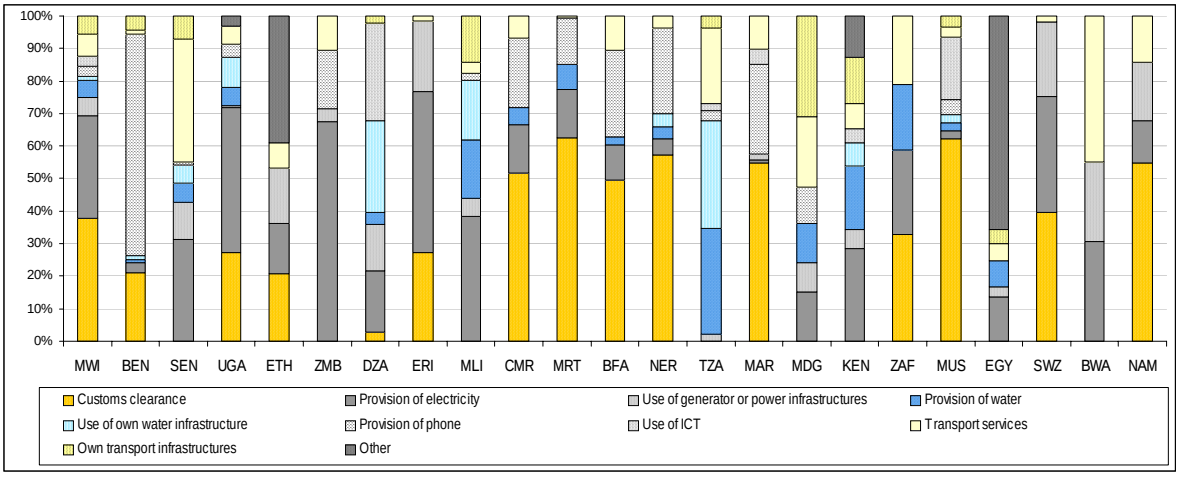


Figure 6.24 Infrastructure's impact on average log productivity by key factors (I)

A. Percentage absolute contribution of infrastructure to average log-productivity



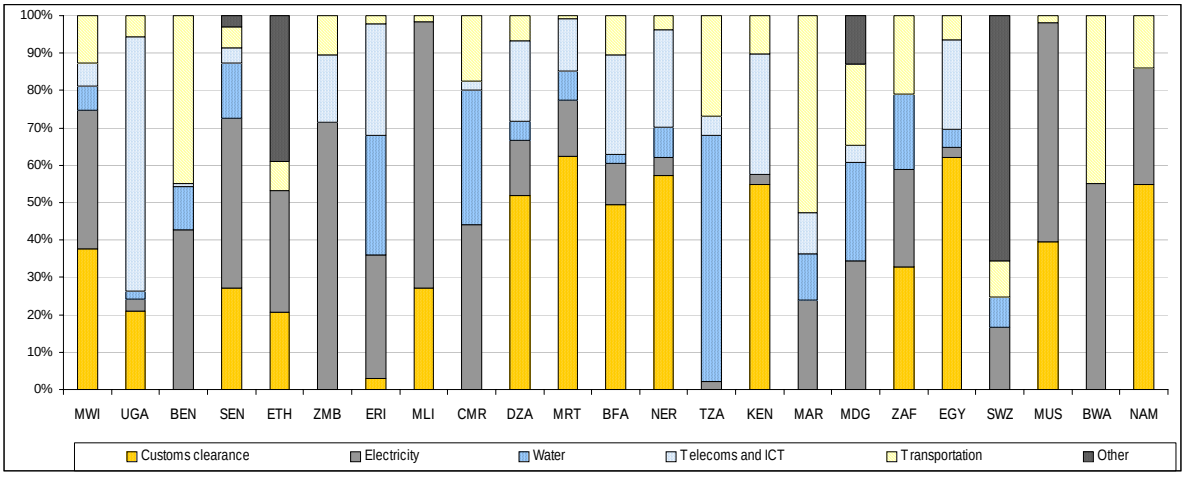
B. Percentage absolute contribution of infrastructure to average log-productivity by key factors



Source: Author's calculations with IC data.

Note: Customs clearance includes: days to clear customs to export and import; shipment losses in customs; inspections in customs; wait for an import license. Provision of electricity includes: power outages; avg. duration of power outages; losses due to power outages, wait for an electricity supply; power fluctuations; avg. duration of power fluctuations; cost of electricity from the public grid; cost of electricity from private system. Use of power infrastructures includes: dummy for own generator; electricity from own generator; dummy for own power infrastructures (excl. generators). Provision of water includes: water outages; avg. duration of water outages; losses due to water outages, wait for a water supply; cost of water from the public grid; cost of water from private system. Use of water infrastructures includes: dummy for own water infrastructures; water from own well. Provision of phone includes: phone outages; avg. duration of phone outages; losses due to phone outages, wait for a phone connection. Use of ICT includes: dummy for e-mail; dummy for webpage. Transport services includes: sales lost due to transport delays; sales lost due to delivery delays; shipment losses; low quality supplies; transport delays. Own transport infrastructures include: dummy for own roads; dummy for own transportation for workers; products with own transport. Other: inventories, illegal payments to obtain public utilities.

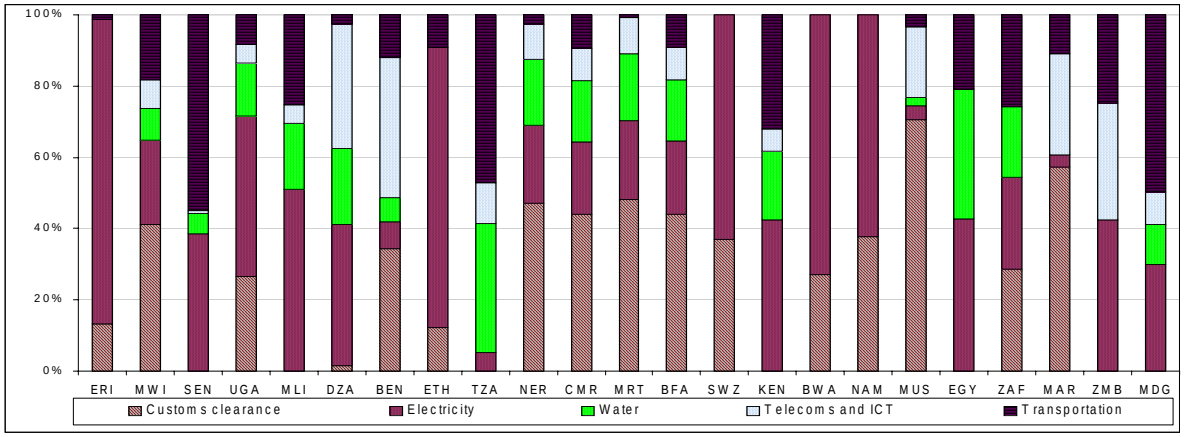
Figure 6.25 Infrastructure impact on average log productivity by key factors (II)



Source: Author's calculations with IC data.

Note: For a description of the variables contained in each group see footnote in Figure 6.24

Figure 6.26 Infrastructure's impact on average productivity by key factors via simulations

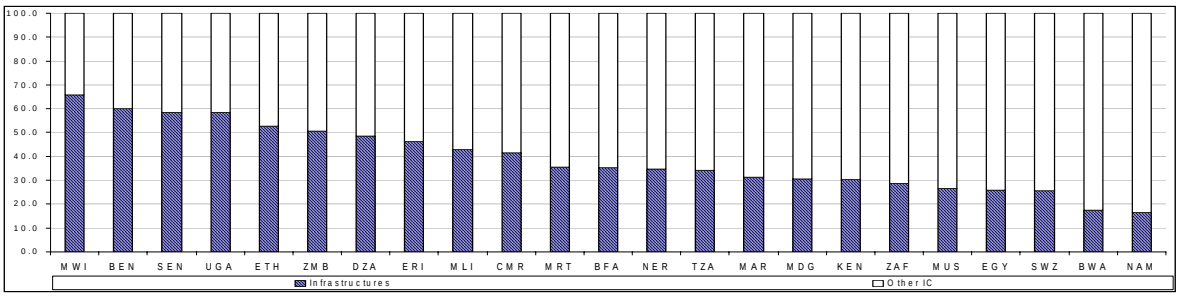


Source: Author's calculations with IC data.

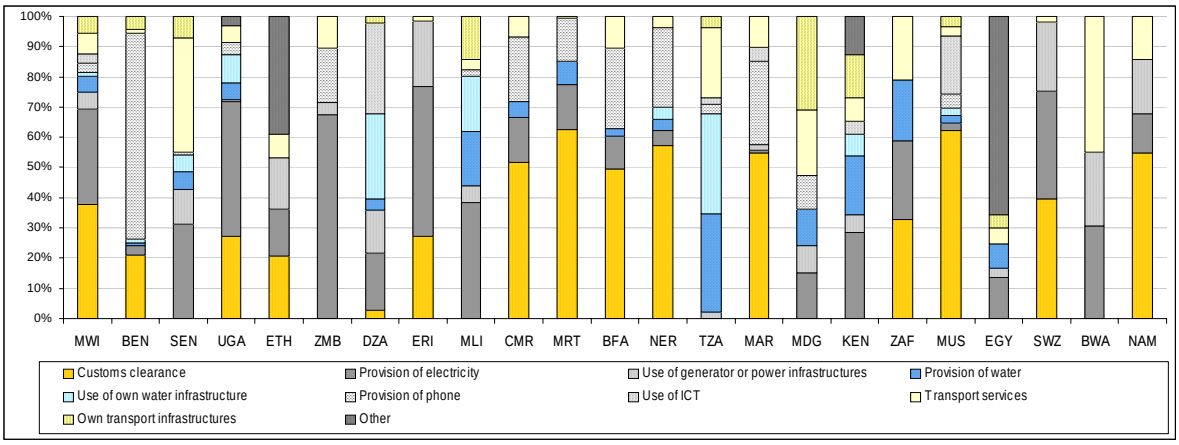
Note: For a description of the variables contained in each group see footnote in Figure 6.24

Figure 6.27 Infrastructure impact on allocative efficiency in logs by key factors (I)

A. Percentage absolute contribution of infrastructure to allocative efficiency in logs



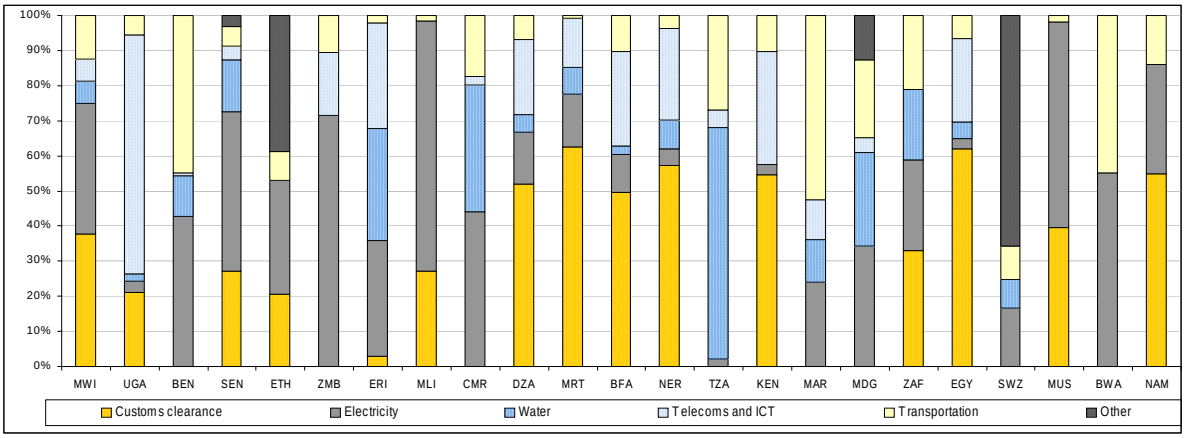
B. Percentage absolute contribution of infrastructure to allocative efficiency in logs by key factors



Source: Author's calculations with IC data.

Note: For a description of the variables contained in each group see footnote in Figure 6.24

Figure 6.28 Infrastructure's impact on allocative efficiency in logs by key factors (II)



Source: Author's calculations with IC data.

Note: For a description of the variables contained in each group see footnote in Figure 6.24