The Role of Telecommunication Infrastructure in the Regional Economic Growth of Africa

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Abstract:

This paper deals with the effects of telecommunications on the economic growth in African countries. The telecommunications sector became a vital sector during the era of the economic reform that has been characterising the continent. We investigate empirically the role of telecommunication infrastructures on long-run economic growth in African countries, for the span of time from 1984 to 2005. We use the panel data approach with a dynamic fixed effect model, which evidences that telecommunications contribute in a major way to the economic development of the continent. It is a crucial determinant, as findings indicate a significant and positive correlation between telecommunication infrastructures and regional growth in Africa, after controlling for a number of other factors. Results also show that investment in telecommunications is subject to diminishing returns.

Jel classification: H54, O47, O55

Keywords: Infrastructure; Growth; Africa; Panel

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1. Introduction

The telecommunications sector has been doing great progress, more than other infrastructure sectors and its growth rate has been steadily improving during the last two decades, due to the liberalisation process which most African countries had to forgo in the 90s, forced to do so by the international institutions (IMF and World Bank) in charge of development. The periods of economic reform coincided with the era of convergence between information and communication technologies (ICT), which was going on all around the world. This condition enabled the low-cost diffusion of ICT products and services in developing countries and it saw many of them actively participating, especially those of East Asia. The African countries, which liberalised their economies to make them more competitive in order to attract foreign investors, had to liberalise the telecommunications sector by opening their markets and even by privatising most of their state-owned companies. These processes have had a huge impact on the telecommunications sector which saw many new operators appearing on the scene providing various services and a new dynamic within African markets which involved African companies in doing business on the continent and producing a positive spill-over within the sector and on the growth rate of the economies. The introduction of competition and the economic reform has contributed enormously to the growth of the telecommunications sector, which had an effect on the structure of economies traditionally dominated by the agriculture sector. Even if, according to the theoretical approaches, there are two different schools of thought on the role of telecommunications in development[1]. The first school holds that telecommunications infrastructure has a positive effect on development, (Castells 1998; Masell & Wehn 1998; Nulens & Audenhove 1999.), while the other school regards telecommunications as having a negative effect on development and contributing to the expansion of the information gap between the rich and the poor, the literate and the illiterate. (Van Dijik,1999; Mansell, 1999/36; Sassman, 1999/18). There is a growing body of research suggesting that

[1] Technophilic are those who think that telecommunications have a positive effect on development, because they believe in the perspective that the economy, information, communication and technology will expand productivity and improve employment-opportunities, the condition and quality of work for many occupants and offer a lot of opportunities for small scale, independent and decentralized forms of production. Technophobic are those who claim that telecommunications can increase the existing inequality between the different groups within the country or between countries, because they assume that the huge investment that is required to strengthen the nation's capabilities for using ICT may divert resources from other activities which could have created a great development impact and that may have destroyed more jobs than were created.

telecommunications are an essential tool for economic regeneration. Telecoms have a dramatic impact on GDP and lead to an increase in foreign direct investment.

Most African policy-makers also recognized that their countries were in need of these reforms to be able to attract foreign investment especially in the infrastructure sector where their continent is lagging behind the others, in order to improve the development of the economic and social condition of the area. It has been demonstrated that investment in telecommunication infrastructure in particular has a positive effect on economic growth in many ways[2]. The effects of telecommunication investment lead to growth by increasing the demand for goods and services used in their production; the economic return on these investments are far greater than the return from the investment alone, because there is a direct and an indirect effect on the production (Canning 1999). So its multiplied effect on GDP is bigger. On the other hand telecommunication services also increase the productivity of the economies in general by facilitating the information flow and by enhancing the communication between buyers and sellers, rural and urban areas and within the industrial sector[3]. Both the fixed costs of acquiring information and the variable costs of participation in the market are lowered by the improvement of the ICT sector, as was argued by Norton (1999). Nandi (2002) mentions that when a telecommunication infrastructure exists, in equilibrium, idle resources are lower and markets are more efficient than when there is no telecom infrastructure, or no equilibrium.

In sum our objective in this paper is to verify if the telecommunication sector, which has been one of the principal beneficiaries of the economic reforms[4] has had a positive effect on economic growth and social development on the continent. Using a panel dataset of 40 African countries spanning from 1984 to 2004, we assess the impact of a long-run relationship between telecommunication infrastructure and regional economic growth during the period of the reform of telecommunications in Africa. To my knowledge this is the first time that econometric analysis is conducted with a sample, which is deliberately restricted to African countries, in order to identify the specific degree of influence that telecommunications factors have in the region. Focusing on African countries we can find the positive and significant impact of telecommunication infrastructure on economic growth as given in developed countries and in China. The relation

[2] Canning (1999) shows that investment in telecommunications and telephone business is substantially more productive than investment on average, due to the existence of externalities.

[3] See Nandi 2002

[4] SAP: (structural adjustment program)

between telecommunication infrastructure and regional economic growth in Africa has the nature of diminishing returns to scale.

For the purpose of this paper we have the following structure: The next section discusses the literature review. Section 3 presents the situation of telecommunications in African countries and the reforms introduced in the sector, while we outline in section 4 the fixed-effect dynamic growth method used in this study and elaborate on data sources. In the final section we analyse the results of the estimation and present the final conclusions.

2. Literature review

We provide a brief overview of the theoretical considerations, which might explain the links between telecommunication infrastructures and economic growth. There are several studies which have focused directly on the effects of telecommunication infrastructure on economic growth, particularly the early seminal paper by Jipp (1963), using data for different countries, identifying the positive association between the two variables; since then, there have been a lot of studies which investigated the relationship between telecommunication infrastructure investment and economic growth, using different econometric methods, finding empirical evidence for a strong and positive relationship between investment in telecommunication and economic growth, with great return on developing countries, as pointed out by Dholoakia and Harlam (1994).

From this point of view we can say that the effect of telecommunications on growth depends on the different stages of development of the country or region taken into consideration, as the study by Bee and Gilling (1976) verifies. We do this by constructing three indices: a telephone index represents the availability of telephone facilities and their use, an index of economic performance and a development supporting index representing other supporting factors needed in economic development. These analyses show an intense relationship between the telephone index and the index of economic performance and they also explain the role of the contribution of telecommunications to the economic development.

Furthermore, Dholoakia et al. conducted another study using multiple regression models to analyse the connection between a number of factors such as education, energy, telephone-lines, other physical infrastructures and economic development. The results suggest that simultaneous investment in the development input such as education, telecommunications and other infrastructure variables are complementary in helping to promote economic growth, while Hardy (1980) was the first to estimate the impact of telecommunications on growth using two different groups of the 45 countries he had on his sample. He divides the countries into developed and less developed

countries, finding that there is a larger effect on the less developed countries than on the developed countries.

The most influential of the recent studies are those of Saunders, Warford and Wellenius (1994) and the World Bank report (1994) which examine the role of telecommunications in economic development, and find some positive and significantly robust effects, noticing that the investment in telecommunication infrastructure enhances economic activity and growth, part of the consequence of this growth results are spent on telecommunication services which will stimulate further telecommunication investment. These reports revitalised the interest of researchers in these themes and since then they started paying attention to the investment in telecommunication infrastructures. There are many recent empirical studies evidencing the positive relationship between telecommunication infrastructure and aggregate output. Some of these studies applied different estimation methods, like those we will examine now. Easterly (2001) reports that a measure of telephone density contributes significantly to explain the growth performance of developing countries over the last two decades, while Loayza, Fajnzylber, and Calderon (2003) find that the same telecommunication indicators are vehemently related to growth in a large panel data set including both industrial and developing countries. Apart from this there have been empirical studies looking at the returns to public infrastructure investment, as indicated by Roller and Waverman (2000), which evidence how telecommunication infrastructure is characterized by network externalities and that the positive growth effects of investment in this sector become a critical mass in a given country's communication infrastructure. They achieved these results using the sample of 21 OECD countries over a 20-year period to estimate a micro-model for telecommunication using a macro production function.

Another part of the studies looked for the direction of causality, which exists between these variables, accepting Jipp's curve as a stylised fact. Taking into consideration whether it is economic growth, which causes the growth of the telecommunication sector or vice versa. Among them we find Lee (1994) who analyses the relationship of South Korean main lines growth, number of telephone sets, gross capita investment expenditure, and gross investment for 1963 to 1988 and finds a positive effect. The inferred process is that increased telecommunication infrastructures stimulate economic growth by providing the necessary infrastructure for business.

Applying Granger, Sims and the modified Sims test to the U.S.'s economic growth and telecommunication investment data for a period spanning from 1958 to 1988 Cronin, Colleran and Gold (1991) identified a process in which telecommunication investment promotes economic growth and this growth increases the demand for telecommunication infrastructure.

Madden and Savage (1998) empirically examined the relationship between telecommunication infrastructure investment, gross fixed investment and economic growth for a sample of transitional countries of Central and Eastern Africa. The results of their estimation show a strong association between the two variables, but they did not establish a causal relationship.

The review of the literature has positively shown the empirical evidence that investment in telecommunications enhances the efficiency of economic activity which improves productivity and at the same time economic growth stimulates the demand for telecommunication, as argued by Maddock (1995) who holds that when a nation's telecommunication sector grows faster than the overall rate of economic growth, it promotes the nation's productivity in a way in which the telecommunication sector is a leading sector. Countries as those of East Asia could be taken as an example of a nation in which the fastest growing telecommunications sector leads the economy by speeding up the diffusion of information and creating the formation of skilled labour which in turn affects the productivity and the growth of the nation.

3. The situation and the evolution of the market of telecommunication in Africa

The African telecommunications sector has drastically changed during the last two decades, which have witnessed many African countries having a considerable development in the mobile communication sector rather than in the fixed line system, countries such as Nigeria, Uganda and Cote d'lvoire having more mobile telephony than fixed line. It's a result of the dynamism, which this particular sector has had in African economies due to the technological revolution with the development of wireless and mobile communication and the economic reform, which the international institutions have prodded many countries to undergo.

By the end of the 80s, when many African governments started to undertaking economic reforms, the telecommunications sector, which was the state owned company and could not effectively provide its service, was presenting a very poor performance.[5] In Africa the number of fixed line service monopolies is the largest in the world, accounting during that period for about 37%, compared to 23 % in Asia, 19% in the Americas, 14% in Oceania and 7% in Europe (ITU, 2007). Now that most African countries are privatizing their fixed lines, incumbent operators are liberalizing the telecoms sector and the states are going through a regime of regulation to attract the investments from high-income countries, which participated in the process of privatisation. More

[5]See Wellenius et al. (1992)

than 36 countries have created a separate regulatory sector, about 45 countries have licensed private cellular operators and effective cellular competition has sprung up in many countries in the region (ITU). As a consequence of the market structure fixed line telephony is the less competitive service in Africa, while the mobile and the internet markets have always been in private hands, with 93% of the economies having achieved partial or full competition. In order to create a really competitive market between the different operators and to let the customers and the sector benefit from the competition it is important to institute an independent authority which will have to be vigilant on the functioning of the market, with a sound regulatory environment to be established; according to (ITU) about 83% of the African economies had established such an authority around the end of 2006 which was intended to regulate the telecommunications market and to create competition through lower prices, better quality of services and openness to innovation in a regulated telecommunications market.

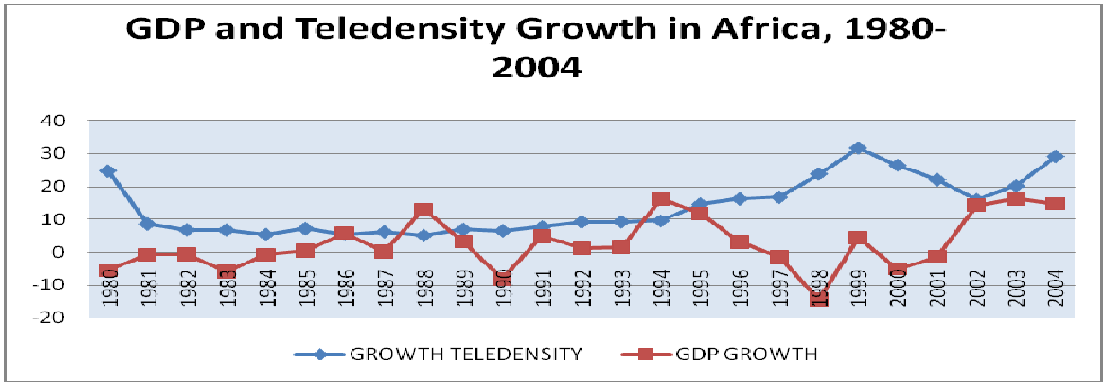
However, the continent still lags behind compared to other developing regions such as Asia and Latin America. Looking at 2006 data the worldwide fixed mainline telephones are 1,270 million, Africa has less than 2% compared to the 48% of Asian countries and Brazil alone has a total number of telephones which is higher than the one of the whole African continent. In general the main fixed line penetration was 3.1 per 100 inhabitants compared to 32.4 main line in the Americas and 39.7 in Europe in 2006, with a world average of 19.5 main fixed lines, which is six times higher than the penetration rate of Africa.

Within the continent the fixed line is concentrated in just 6 of the 54 countries, Algeria, Egypt, Morocco, Nigeria, South Africa and Tunisia. These account for almost 80 percent of all fixed lines in Africa, which are located only within the urban towns. The differences between the rural and urban areas in terms of telecommunication are very dramatic, because the tele-density in the rural areas is particularly low, considering that in these areas where a great part of the population (two third of the African population) lives less than 3% of the population currently has a fixed line telephone connection.

For the mobile cellular market, the situation looks much better. The sector is noted for an impressive growth rate and the development of mobile telephony during last decade has witnessed an annual growth of about 49% (see figure 1 and 2). Africa has added another 55, 3 million mobile cellular subscribers to its subscriber base. During the period between 2001 and 2005 Africa achieved the huge growth rate of 46% of mobile subscribers and the potential of Africa's mobile market is still very large, in comparison to the saturated markets of Europe and the United States which have a mobile penetration of 94, 3 per 100 inhabitants and 62 per 100 inhabitants, compared

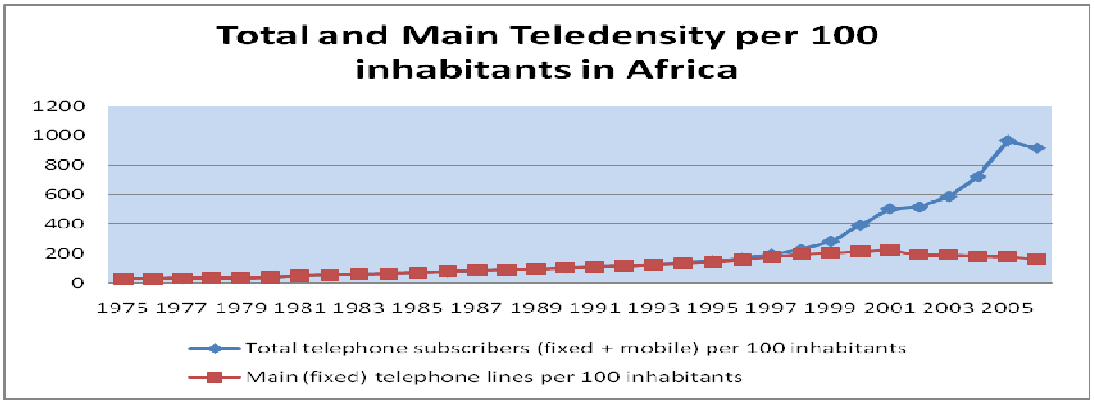
to 22 per 100 inhabitants in Africa and 29, 3 per 100 inhabitants in Asia. The growing numbers of new subscribers report for all the African countries except those six countries which had 80% of the African fixed main line; but in many sub-Saharan countries, such as Gabon, Namibia, Cape Verde, Seychelles and Mauritius which are among those who had the highest penetration rate of Africa's total tele-density (add mobile and fixed main line per 100 inhabitants), their rate of penetration has improved much due to the spread mobile cellular subscribers. For example today the Seychelles are the African country with the highest penetration rate; meaning that on the islands everybody has signed up for a phone connection or bought a SIM card, but it was not among those ten African countries which had the highest fixed line rate. From this observation we can imply that in Africa the number of mobile cellular subscriptions is higher than that of the main fixed line subscriptions. Africa is the only region where more revenues were generated from mobile services than from fixed line services (ITU).

Figure 1



Source: ITU (2007)

Figure 2



Source: ITU (2007)

Concurring the internet-service, Africa is facing problems both of the quantity and of the quality of the service, even if this sub-sector has been the most dynamic telecommunications market in Africa. The limitations and obstacles on the path of rapid internet-growth rate are mainly due to the lack of infrastructure, affordability, low internet bandwidth, unreliable electricity and outdated end-user technology. In Africa the number of internet subscribers in 2006 was 1, 3% of the population, but taking into consideration that an internet subscription is always used by different members of the household, by all the clients of an internet café, by visitors at the library, it was estimated that the effective internet users in Africa represent more than 4,8 users per 100 inhabitants according to (ITU). The situation within Africa varies too much with countries such as the Seychelles, South Africa, Egypt and Tunisia doing much better than other countries. The highest penetration rate is 35,7 per 100 inhabitants for the Seychelles, followed by other countries far behind with differences of 10 points.

The slow rate penetration of the fixed line service is due to the inefficient investment, the insufficient private sector involvement, a poor management incentive and the scarcity of foreign exchange, as mentioned by Gebreab (2000), without forgetting the low level of GDP that many African countries have had during this period and the low population density that exists in the continent.

All of the factors are a result of the nature of the market, which is a characteristic of the developing countries' telecommunications sector formed by state-owned telecommunication providers. The reasons for the low penetration of fixed mainline services are that there was a need of huge investment which many African small-economy countries could not permit themselves, especially during the 80s when many African countries were facing serious financial problems. The distribution of telecommunication services was very different between the rural and urban areas and the rural areas having a level of fixed main lines, which is irrelevant compared to the urban areas. However the introduction of recent technological advances is transforming the telecommunications market in such a way that many people living in the rural areas or in the villages within Africa have by now gained access to telecommunication services, because most of their areas today have coverage of the mobile signal: countries such as South Africa, Comoros, Kenya, Malawi, Mauritius, Uganda and Namibia have 90% of coverage of their rural areas with mobile signal. This will enable the rural areas to widen their market and to create a better information flow, larger markets and lower transactional costs.

4. Methodology

The objective of this paper is to verify the role which telecommunication infrastructures play by explaining the different growth performances across African countries and the methodology employed in this study is similar to Kingsley et al. (2007)[6] and Datt and Agarwall (2004)[7] in their studies of the impact of telecommunication infrastructure on regional economic growth in China and 22 OECD countries. They used the dynamic fixed effect panel data model following Islam (1995) which is more appropriate in taking into account the correlation between the previous and subsequent value of growth, besides accounting for separate country effects. In the model the short run autoregressive behaviour of the dependent variable is captured by the lag of the dependent variable.

We will follow the Barro and Sala-i-Martin (1991, 1997) seminal work method, which examines the determinants of economic growth. This approach enables us to test the conditional convergence hypotheses by adding to the Solow equation a set of variables reflecting differences in steady-state equilibrium. The condition convergence theory works when a negative, partial correlation occurs between growth in income over time and its initial level. The growth analysis is based on a pooled data set of cross-country and time-series observations (yearly period observations of 40 African countries out of 53, over the period of 1984 to 2004). We will follow the method used according to this study and we will investigate the role of telecommunications infrastructure using a panel approach. The growth equation is thus extended to include the effect of telecommunication infrastructure on growth, which has the following form:

$$GR_{it} = \alpha_i + \eta_t + \beta_1 GR_{i,t-1} + \beta_2 \ln(gdp)_{i,t-1} + \beta_3 Tele_{it} + \beta_4 DET_{it} + \varepsilon_{it} \quad (1)$$

Where i indexes countries; t indexes time; α_i captures the country fixed effect; ε_{it} is the transitory error term; GR represents the annual growth rate of the real GDP per capita; GR_{t-1} is the lagged of the annual growth rate of the real GDP per capita and gdp_{t-1} represents lagged real GDP per capita. The lagged GDP variable is included to test the convergence in a panel data approach. The

[6]Explaining the role of telecommunication infrastructure in the regional economic growth of China. It found that telecommunication is both statistically significant and positively correlated to regional economic growth.

[7]Using the data of 22 OECD countries, their results show a significant and positive correlation between telecommunication and growth, after controlling for a number of other factors.

convergence hypothesis according to neoclassical growth theory suggests that due to diminishing returns to capita, the growth rate of a country is inversely proportional to its initial level of income; the higher level of past GDP, the lower the subsequent growth.

Tele is a measure of telecommunication infrastructure. The variables contain the number of telephones per 100 inhabitants, including both fixed lines and mobile penetration per 100 inhabitants. The expected sign of the telecommunication variables is positive, as the previous studies[8] have indicated. Looking at the literature, there has been great evidence of the fact that the positive relationship between telecommunication and economic growth is a result of reverse-causality[9,] implying that the higher telecommunication investment is the result of higher growth and not vice versa. In order to confirm that the results are not simply due to reverse causality, this relationship is tested using current and lagged values of telecommunication ($Tele_{t-1}$, and $Tele_{t-2}$) and their expected sign is positive.

The DET represent the set of other various standard growth determinants such as population growth rate, which is introduced to show the effect on economic growth. The expected sign has to be negative, as if the population lowers growth relates to higher GDP per capita. Investment and foreign direct investment are also part of the set of the standard growth determinants and their correlation with economic growth is expected to be positive, as indicated by the robustness of this relationship in the previous studies.

In order to verify the nature of return to scale to telecommunication investments, (TeleSQ) the square of the telecommunication variables is included in a separate model. The objective of using the square of the variable is to examine whether the relationship between economic growth and telecommunication is linear or not.

$$GR_{it} = \alpha_{it} + \eta_{it} + \beta_1 GR_{1,t-1} + \beta_2 ln(gdp)_{1,t-1} + \beta_3 Tele_{it} + \beta_4 DET_{it} + \beta_5 TeleSQ + \varepsilon_{it} \qquad (2)$$

The equation (2) has the same variable as the first equation plus the square of the telecommunication variable. That indicates the nature of return to scale of the telecommunication variables, in the case that if the coefficient of (TeleSQ) is negative and significant while the coefficient of (Tele) is also positive and significant, then we can support the diminishing returns

[8]Data and Agarwal (2004), Waverman and Roller (2001) have indicated that there is a two- way causation between telecommunication investment and economic growth.

[9] Cronin et al. (1991) , Madden and Savage (1998): both studies found the evidence of a two- way causation between telecommunication investment and economic growth.

hypothesis; implying that the investment in telecommunication infrastructure widens its incremental effect on growth diminishment. On the other hand a positive sign of both coefficients would indicate increasing returns while if the signs are reversed, that is that the coefficient of (TeleSQ) is positive and that (Tele) is negative, then we have evidence in support of a critical mass theory, as investment in telecommunication infrastructure would not significantly affect economic growth, until a critical mass of telecommunication infrastructure is achieved (Roller and Waverman, 2001).

5. Data and variables

We estimate growth regressions on pooled cross-country and time-series data covering 40 African countries over the period 1980-2004. The data is organized on a yearly basis and each country has many observations (see table 1).

We define our dependent variable as the growth rate of real per capita gross domestic product (GDP), measured as the log differences of per capita output. In turn per capita output is measured as GDP divided by the total population; it is constructed using the World Bank development indicator (2006). Our set of growth determinants can be classified following Datta and Agarwal. (2004): Macroeconomic data on GDP, population, investment, foreign direct investment, importation and exportation taking from (WDI 2006), meanwhile the telecommunication data is obtained from (ITU 2007).

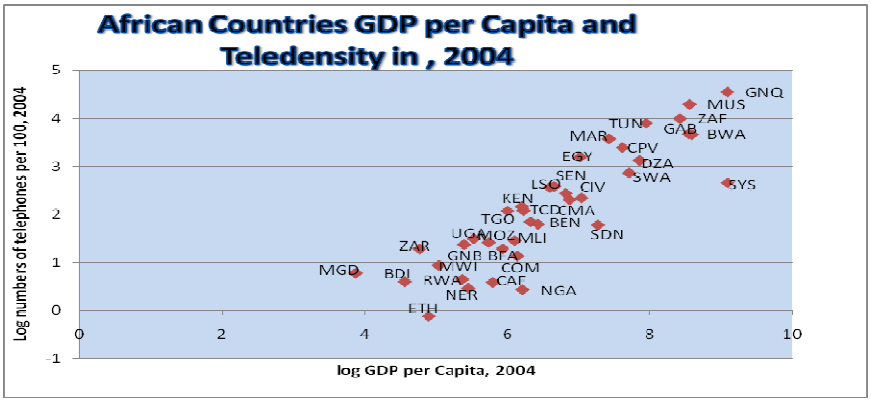
Table 1 –Summary statistics

Variable	Obs	Mean	Std.Dev	Min	Max
Grow.GDP per capita.	1026	0.01	0.3	-4.6	4.5
Real GDP per capita	1069	6.4	1.09	2.09	9.45
Openness	948	25.9	21.21	1.5	171.82
FID/GDP	980	2.4	7.3	-8.5	145.132
Tele-density	1074	4.5	10.7	0.01	99.44
Pop. Growth	965	2.6	1.63	-36.7	21.7
Investment	968	0.21	0.13	0.02	2.1

The telecommunication indicator is the number of telephones set per 100 inhabitants, (tele-density) including both fixed lines and mobile. Most previous studies measure the telecommunication

infrastructure with the number of main lines (Savage et al. 2003; Hardy 1980; Demurger 2001). Look at (figure 3) which confirms the positive relationship between tele-density and economic growth in a sample of African countries.

Figure 3



Source: ITU (2007)

In (table 1A, appendix A) we present 48 African countries GDP per capita of 1980 and 2004 and their compound annual growth rate from 1980 to 2004, population growth rate from 1980 to 2004, telephone per 1000 inhabitants in 1980 and 2004 and compound annual growth rate from 1980 to 2004. An examination of the variables shows that the 48 African countries of the sample in 1980 had an average GDP per capita of 804 US$, after 24 years their GDP per capita has increased to 998 US$ with an average annual growth of only 0,4%, while their population has had an annual growth rate of 2,5%. The situation within African countries is quite different during the two decades because most African countries had to face different economic crises, which started with sharp reductions of price and primarily commodities and led to the debt crises of 1980s. In this period (1980-2004) only six African countries[10] had an annual growth rate of GDP per capita above 2%, while 20 countries had less than 2%, but with a positive annual growth rate, although the majority of them, 22 out of 28 countries, witnessed a negative annual growth rate of the GDP per capita.[11] Most of the dramatic drops were observed by countries such as Liberia: -7%, Zaria: -4, 3%; Cote d' lvoire: -2%, Niger -1,9%.

[10]They are Botswana: 5,4%; Cape Verde: 3,1%; Chad: 2,6%; Egypt: 2,6%; Lesotho: 2,4%; Mauritius: 4,2%.
[11]Most of the countries, which had a negative growth rate of their GDP per capita, were countries undergoing civil wars, persistent political instability and poor economic policies.

6. Estimation results

Table (2) presents the regression results using the basic framework of equation (1) and the explanatory variables just described. The dependent variable is the annual growth rate of the real GDP per capita over the period from 1984 to 2005. The regressions apply to the data set for about 40 African countries using the dynamic panel fixed effect model. In all the columns of the table the results show that the coefficient of the lagged dependent variable, GRTH, is positive but not significant. The results also show strong evidence for conditional convergence; the coefficient on the logarithm of lagged GDP in log value is negative and significant at a 1 % level. Thus, a poor country with lower initial income level grows faster, with the variables influencing the steady state level of income controlled. The coefficient implies that a country at the half of the income level of another country grows 18, 7 percentage points faster than the richer country.

Table 2 - Determinants of Economic growth in Africa., 1984-2004

	A	B	C	D
GRTH (t-1)	0.05 (0.039)	0.04 (0.039)	0.05 (0.393)	0.06 (0.039)
Log (GDP_1)	-0.29 (0.025)***	-0.28 (0.025)***	-0.28 (0.025)***	-0.30 (0.025)***
Invest	0.23 (0.092)**	0.26 (0.093)**	0.23 (0.092)**	0.24 (0.092)**
Pop	0.015 (0.003)***	0.01 (0.003)***	0.01 (0.003)***	0.016 (0.003)***
FDI	0.161 (0.449)	0.011 (0.049)	0.011 (0.050)	0.014 (0.049)
Openness	0.01 (0.001)***	0.01 (0.001)***	0.007 (0.001)***	0.007 (0.001)***
TELE	0.005 (0.002)***			0.01 (0.004)***
TELE_1		0.005 (0.002)**		
TELE_2			0.006 (0.002)**	
TELE_sq				-0.001 (0.001)**
intercept	1.48 (0.151)***	1.47 (0.151)***	1.40 (0.151)***	1.46 (0.00)***
R-sq	0.41	0.41	0.40	0.42
Obs	618	618	618	618

Table 3 - Determinants of Economic growth in Africa. 1984-2004

	A	B	C	D
Log(GDP_1)	-0.270(0.024)***	-0.27 (0.024)***	-0.266(0.024)***	-0.29 (0.024)***
Invest	0.24 (0.092)**	0.24 (0.093)***	0.135 (0.031)**	0.25 (0.091)***
Pop	0.015 (0.003)***	0.015(0.003)***	0.015 (0.003)***	0.015 (0.003)***
OPENNESS	0.007 (0.001)***	0.007(0.001)***	0.007(0.001)***	0.007 (0.001)***
FDI	0.019 (0.49)	0.015 (0.49)	0.001 (0.142)	0.019 (0.490)
TELE	0.004 (0.001)***			0.012(0.004) ***
TELE_1		0.006 (0.002)**		
TELE_2			0.006 (0.036)**	
TELE_sq				-0.001(0.0008)***
Constant	1.394 (0.000)***	1.43 (0.148)***	1.43 (0.148)***	1.476(0.147)***
Observations	618	618	618	618
Number of ID	41	41	41	41
R-squared	0.41	0.41	0.41	0.41

The investment rate also has a significantly positive effect on growth rate, confirming the importance of physical capital accumulation for Africa countries. The estimate coefficient indicates that an increase of the investment/GDP ratio by 10% is associated with an increase of 1, 3% in the average annual rate of the real per capita GDP[12]. The regression results provide the significant relationship between openness and per capita GDP growth. The coefficient shows that an increase in outward-oriented economic policies of 10% would have an increase of 1% in the average annual

[12]Our estimated coefficients confirm most previous studies on economic growth in Africa: Knight, Loayza and Villanueva (1993) get an estimate of 0,118 for a group of 76 developing countries. Levy (1988) obtains a coefficient of 0,13 for 1968-82. Savvides (1995) employing a fixed effect model to estimate the determinant of economic growth across a sample of African countries obtains the coefficient of investment 0,139.

growth rate of GDP per capita. The effect of openness confirms the finding of previous studies,[13] i.e. that the role of international trade is beneficial for economic growth in Africa. The effect of foreign direct investment is positive, but significant only at a 10% level, which can be due to the fact that there are relatively low levels of foreign direct investment flowing in Africa especially in the 80s. The estimated coefficients of the population growth rate are found to be positive at 1% level of testing in most of the estimations.

The coefficient of the telecommunication variable, which is the number of telephones per 100 inhabitants, is positive and significant at a 1% level. It implies that there is a strong impact of the telecommunication infrastructures sector on regional economic growth of African countries. The results of the model A (column A) show that an increase of 10% of the tele-density would have an increase of 0,04% of the GDP per capita. Generally the model confirms that telecommunication infrastructure does contribute positively to regional economic growth in Africa. In order to verify that this result is not due to reverse causality, we use the lagged values of tele-density and the estimates on (column B and C) giving support to the argument that the positive relationship is not due to the results of reverse causality. The coefficient of the two lagged is positive and significant at 5% level. Showing that telecommunication infrastructure does have positive impact on regional economic in Africa.

In (column D) we report the estimation of (model 2) which included the square term tele-density in the model in order to evidence the test of non- linearity between telecommunications and economic growth. The coefficient of TELESQ is significant and negative at a 5% level, while the coefficient of TELE is positive and significant at 1% level. The results provide some evidence for the argument of diminishing returns of telecommunication infrastructure investment in Africa. Meaning that in Africa the size of the effect of telecommunications is inversely related to its prior level. A unit increase in tele-density for countries with a higher level of telecommunication infrastructure has an effect with smaller magnitude on economic growth. This implies that the positive effect of telecommunication on the GDP growth is largest for countries with the smallest telecommunication infrastructure in Africa. These indicate that countries at an earlier stage of development are likely to benefit most by establishing an approximate telecommunication.

[13] Sache and Warner (1997), Temple (1998) , Edwards (1993), Villenanueva (1994).

7. Conclusions

The effect of telecommunication infrastructure on economic growth has been explored in this paper using a dynamic fixed effect method. The results suggest that there is a conditional convergence hypothesis which indicates that countries with higher level of GDP per capita tend to grow at a slower rate. It also evidences that fixed investment, foreign direct investment and outward trade policies have a positive effect on economic growth.

More important is that the results show that telecommunication is both statistically significant and positively correlated to regional economic growth in real GDP per capita growth in Africa. The results are robust even after controlling investment, population growth, past levels of GDP per capita, and lagged growth in GDP per capita. The results further indicate that the telecommunication investment is subject to diminishing returns, suggesting thereby that countries at an earlier stage of development are more likely to gain from investing in telecommunication infrastructure.

From the government policy-makers perspective, the results point out that providing an efficient telecommunication infrastructure is significant for fostering economic growth on the less develop areas in the continent, and more resources should be allocated on investment in the rural area, in order to insure that telecommunication infrastructure target the vast majority of the population.

More afford should be make to encourage and support the role of investors, by creating an effective competition to lower end-user price and establish independent regulatory mechanisms.

The advantage of the telecommunication services should be use for the promotion and diffusion of e-government, e-commerce and e-learning in order to increase effective administration, transparency and public participation.

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Appendix A

Table 1 A – African countries GDP per capita, Pop Growth, and Telephone per 1000 inhabitant

	GDP per capita		CAGR %	Pop Growth %	Telephone per 1000 inhabitant		CAGR %
Countries	1980	2004	1980-2004	1980-2004	1980	2004	1980-2004
Algeria	1826,8	1991,8	0,4	2,3	16,6	70,7	6,3
Angola	861,1	799,1	-0,3	2,9	4,6	6,2	1,3
Benin	292,3	324,1	0,4	3,3	2,3	8,9	5,9
Botswana	1077,5	3671,1	5,3	2,2	6,8	77,1	10,7
Burkina Faso	191,7	248,1	1,1	2,7	1,0	6,3	8,1
Burundi	135,4	107,5	-1,0	2,4	0,5	3,4	8,7
Cameroon	724,1	736,7	0,1	2,5	2,0	6,9	5,4
Cape Verde	623,8	1291,8	3,1	2,2	5,0	148,3	15,3
CAF	313,6	225,3	-1,4	2,3	1,1	2,5	3,4
Chad	142,7	260,7	2,6	2,9	0,1	1,4	10,9
Comoros	404,6	377,8	-0,3	2,3	2,7	23,0	9,4
Congo	958,1	940,2	-0,1	3,2	4,7	3,6	-1,2
ZAR	250,9	88,2	-4,3	2,9	1,0	0,2	-6,8
Cote d Ivoire	923,5	574,2	-2,0	3,2	4,5	12,6	4,4
Egypt	879,9	1614,7	2,6	2,1	9,6	130,3	11,6
Ethiopia	136,2	131,7	-0,1	2,6	1,7	6,3	5,7
Gabon	4688,8	3860,4	-0,8	2,8	14,5	28,4	2,8
Gambia	327,2	327,4	0,0	3,4	3,3	27,4	9,3
Ghana	233,6	275,0	0,7	2,7	3,3	14,5	6,4
Guinea.-B	144,4	133,9	-0,3	2,8	2,3	7,1	4,9
Kenya	435,2	426,6	-0,1	3,0	4,5	8,9	2,9
Lesotho	309,7	542,9	2,4	1,4	2,7	20,7	9,0
Liberia	744,5	130,2	-7,1	2,3	3,6	2,2	-2,2
Madagascar	341,8	229,1	-1,7	2,9	2,1	3,4	2,0
Malawi	161,7	153,6	-0,2	3,0	2,4	7,4	4,9
Mali	220,2	236,6	0,3	2,6	0,7	5,7	9,2
Mauritania	361,8	437,2	0,8	2,6	2,0	13,2	8,2
Mauritius	1570,3	4223,0	4,2	1,0	24,5	286,7	10,9
Morocco	950,3	1348,6	1,5	1,8	8,7	43,9	7,0
Mozambique	179,0	276,0	1,8	2,0	2,7	4,1	1,7
Namibia	2028,9	2034,7	0,0	2,9	29,4	63,7	3,3
Niger	245,5	154,8	-1,9	3,2	0,9	1,8	2,7
Nigeria	425,3	401,6	-0,2	2,6	2,3	8,0	5,3
Rwanda	280,4	249,7	-0,5	2,3	0,6	2,6	6,1
Senegal	405,5	461,2	0,5	2,7	3,0	20,6	8,4
Seychelles	4507,0	6687,7	1,7	1,1	54,3	253,4	6,7
Sierra Leone	233,2	170,1	-1,3	2,1	3,5	4,9	1,4
South Africa	3463,3	3346,1	-0,1	2,1	59,2	105,2	2,4
Sudan	277,3	438,6	1,9	2,4	2,3	29,0	11,3
Swaziland	980,6	1358,1	1,4	2,9	9,2	41,8	6,6
Togo	346,3	244,0	-1,5	3,2	2,1	10,4	7,0
Tunisia	1352,6	2340,7	2,3	1,9	17,5	121,2	8,5
Uganda	176,3	262,4	1,7	3,3	1,6	2,6	2,1
Zambia	450,5	338,7	-1,2	2,7	5,4	7,6	1,5
Zimbabwe	598,7	456,7	-1,1	2,4	13,1	24,5	2,7
AVERAGE	804,0	998,4	0,4	2,5	7,7	37,3	5,6

Source; World Bank Development Indicators 200

Figure 1 A

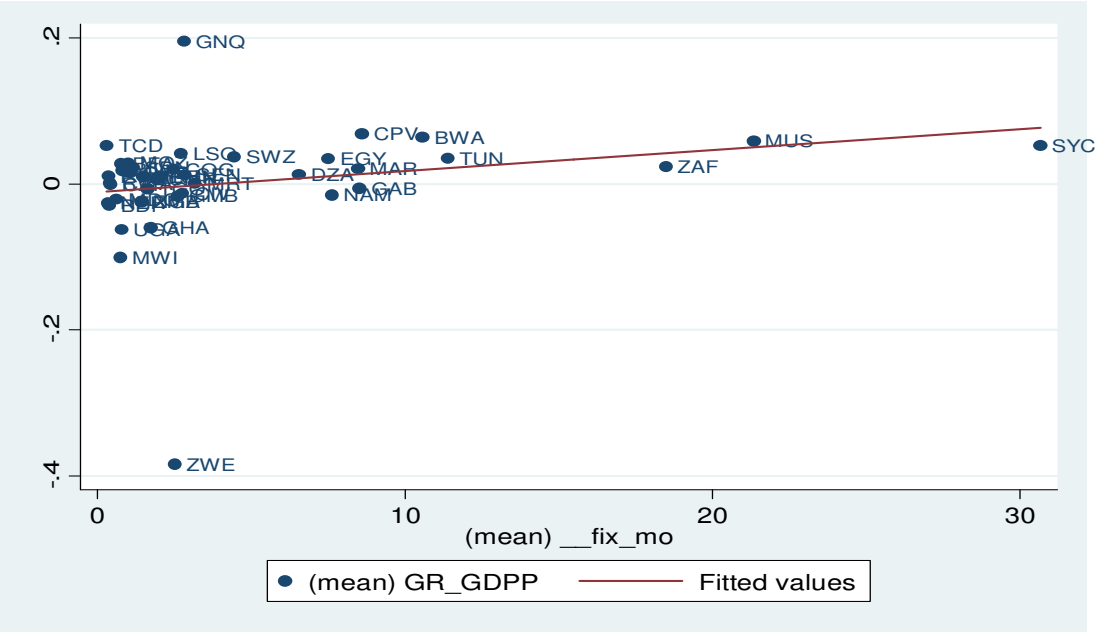
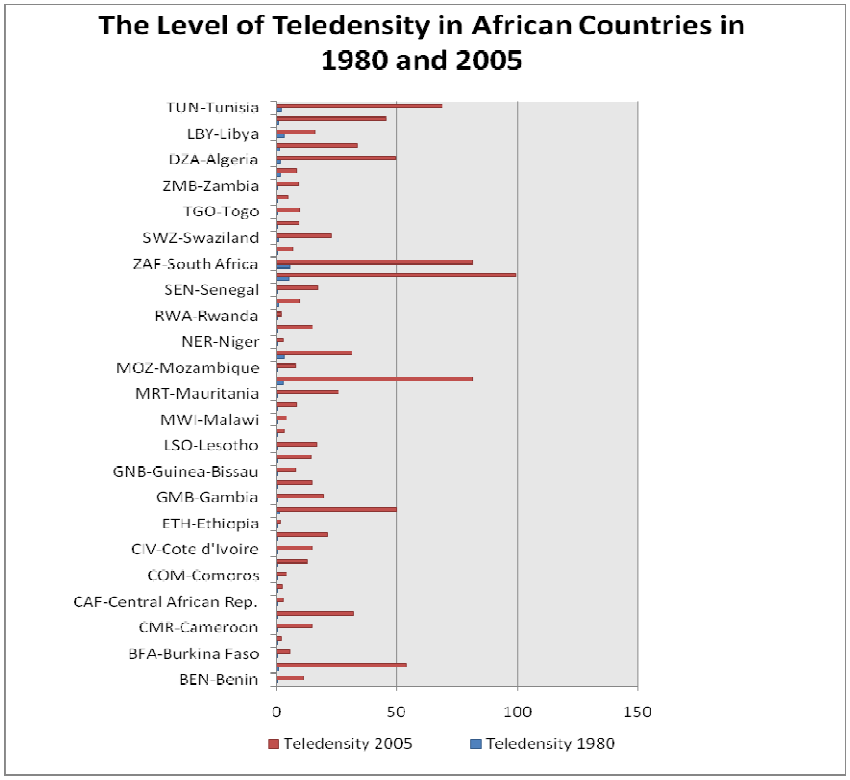


Figure 2 A



Source: ITU (2006)