# FINAL REPORT


# ASSESSMENT OF THE ECONOMIC IMPACT OF TELECOMMUNICATIONS IN FRANCOPHONE AFRICA


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## Columbia Institute for Tele-Information

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## Summary of Findings

The direct positive relationship between information and communication technologies (ICT) and economic development is largely accepted. For decades, economists, social scientists, and policy makers have examined ICT's link to such measures of economic well being as GDP growth, job creation, and productivity. In the past, primarily due to limited data availability, studies examined cross-sectional samples of countries at the aggregate level. More recently, however, with additional information at their disposal, researchers have added a new dimension to the field, focusing on the economic impact of telephony and broadband within a single country. This trend continues in this study, which zeroes in on the effects that wireless telephony and broadband communications have had on four Francophone West African economies: Senegal, Cote d'Ivoire, Mali and Niger.

This study finds that the overarching consensus – that ICT adoption encourages economic growth – also holds true for this region, where it has impacted the economy and employment while allowing the countries to benefit from many positive externalities. The direct effects of telecommunications on the economies of the four countries under study are sizable. Total revenues generated by the telecommunications industries of the four countries amount to US$ 4,107 million, which represent 7.3% of the countries' GDP (see table A).

|  | **Revenues** (USD '000'000) | **GDP** (USD '000'000) | **Percent of GDP** | **Year** |
|---|---|---|---|---|
| Senegal | $1,503 | $14,160 | 10.6% | 2012 |
| Cote d'Ivoire | $1,674 | $24,680 | 6.8% | 2012 |
| Mali | $557 | $10,656 | 5.2% | 2011 |
| Niger | $373 | $6,568 | 5.7% | 2012 |
| Total | $4,107 | $56,064 | 7.3% | |

Table A. Francophone West Africa: Telecommunications Industry Revenues
Source: Senegal (Comptes Nationaux, Sonatel, Hot Telecom, World Bank); Cote d'Ivoire (ATCI; GSMA; IMF); Mali (AMRTP); Niger (GSMA; Pyramid Research)

In addition to its direct monetary contribution to the economy, the telecommunications industry also fuels job creation. In 2011-12, the telecommunications sector of the four countries generated 8,100 direct jobs (within the respective operators), and an estimated 152,000 indirect jobs (employed by providers of inputs to the industry) (see table B).

|  | **Direct jobs** | **Indirect Jobs** | **Direct and Indirect Jobs (*)** | **Country Workforce** | **Percent of Total Workforce** | **Year** |
|---|---|---|---|---|---|---|
| Senegal | 2,795 | 55,000 | 57,795 | 8,847,917 | 0.7 % | 2011 |
| Cote d'Ivoire | 3,399 | 62,315 | 65,714 | 12,936,157 | 0.5 % | 2012 |
| Mali | 1,133 | 20,772 | 21,905 | 7,666,337 | 0.3 % | 2011 |
| Niger | 759 | 13,910 | 14,669 | 9,866,363 | 0.1 % | 2012 |
| Total | 8,086 | 151,997 | 160,083 | 39,316,774 | 0.4 % | |

Table B. Francophone West Africa: Telecommunications Industry Employment
Sources: Senegal (Comptes Nationaux; Sonatel; Hot Telecom); Cote d'Ivoire (ATCI; GSMA); Mali (AMRTP); Niger (GSMA; Pyramid Research); Country workforce: World Bank
(*) Estimated

Furthermore, beyond their direct economic contribution, the telecommunications industries' spillover effects have positively impacted the larger economy in all four countries. For example, between the direct and indirect impact, the telecommunications industry contributes 9.3 % of the GDP of the four countries. Of this amount, the indirect impact (beyond the telecommunications industry) represents over 20% (see table C).

|  | Senegal | Cote d'Ivoire | Mali | Niger | Total |
|---|---|---|---|---|---|
| National GDP (2012) | US$ 14,160 | US$ 24,680 | US$ 10,308 | US$ 6,568 | US$ 55,716 |
| Direct Telecom. Impact | US$ 1,503 | US$ 1,674 | US$ 557 | US$ 373 | US$ 4,107 |
| Indirect Telecom. Impact | US$ 349 | US$ 348 | US$ 377 | US$ 2 | US$ 1,076 |
| Total Telecom. Impact | US$1,852 | US$ 2,022 | US$ 934 | US$ 375 | US$ 5,183 |
| Percent of National GDP | 13.08 % | 8.19 % | 9.06 % | 5.71 % | 9.30 % |

Table C. Francophone West Africa: Telecommunications Direct and Indirect Contribution to GDP (in US$ millions unless indicated, 2012 figures)
Source: TAS analysis

The indirect impact of telecommunications is primarily driven by the contribution of wireless telephony to the economies of Francophone countries. For example, the impact of wireless to GDP growth between 2005 and 2012 reached 22.6% in Senegal and 29.27% in the Cote d'Ivoire. In addition, for the first time we are beginning to measure the impact of wireless broadband. In Senegal, according to our models, the annual contribution of this technology to the GDP reached 1.32%.

Given the positive relationship between ICT and economic growth, the countries in Francophone Africa should encourage policies that foster adoption while also increasing regulatory stability and promoting local content and services development. First and foremost, policy makers must create a high level of regulatory certainty in order to stimulate the capital expenditures that will lead to further deployment of 3G networks, which provide the infrastructure to offer mobile broadband services. Second, while competition in the market has caused a decline in prices and increased operator investment in the sector, it is critical to consider that excessive industry fragmentation is detrimental to sustainability and innovation, ultimately resulting in frictional costs for both the sector and the consumers. Third, to stimulate technology adoption, the government should promote the local development of applications, services, and content.

# 1. Introduction

The relationship between information and communication technologies (ICT) and economic development has long interested social scientists and policy makers alike. Since the mid-1970s, development banks, foundations, and academics have worked not only to understand, but also to measure quantitatively ICT's economic contribution, focusing on such areas as GDP growth, job creation, and productivity.

Through these investigations, research has leaned toward the study of cross-sectional samples of countries, typically limiting the scope to OECD countries or worldwide analysis due to data availability restrictions. This methodology admittedly offered a great deal of knowledge to the field and current work continues to employ this approach. That said, enabled by data availability, modern research has started to extend its reach, shifting from a global view to hone in on more country-specific data and findings. As an example, to understand broadband's economic impact, the authors have conducted studies for Germany (Katz et al., 2010), the United States (Katz and Suter, 2009; Katz et al, 2011), Costa Rica (Katz, 2011b), Chile (Katz, 2012a), Colombia (Katz et al., 2011c), and the Philippines (Katz et al, 2012a).

The following study analyzes the impact of wireless and broadband communications on the economies of four Francophone West Africa countries: Senegal, Cote d'Ivoire, Mali, and Niger. Timing, existing adoption conditions, and market maturity all determine ICT's economic effect. As supported by multiple studies (Hardy, 1980; Jorgenson et al., 2006; Karner and Onyeji, 2007), the introduction of a new technology does not immediately produce significant economic effects. In this context, a comparison of four country-specific studies provides a perspective of the relationship between timing of technology adoption and economic effects.

Mobile phone use varies widely across the four countries examined in this study, ranging from a 33.58% penetration rate in Niger to a 92.45% penetration rate in Cote d'Ivoire, as of 2Q2013. Nevertheless, wireless services have demonstrably affected each country's economy, albeit at different degrees. This study first employs a structural model that depends on four equations modelling the wireless telephony market operation between 2005 and 2013 taking into account:

- Endogenous growth from existing capital and labor together with the telecommunications infrastructure metrics
- Demand for telecommunications services depending on the price and adoption patterns
- Supply and competition of telecommunications taking into account the regulatory and infrastructural investments in ICT
- Revenues and outputs of the telecommunications market as a proxy for the 'health' and sustainability of the market

After assessing the impact of wireless telephony, the study focuses on assessing the economic effects of broadband. Between 2005 and 2013, the uptake of both fixed and

mobile broadband varied significantly across the four countries. In general terms, while fixed broadband is generally at an embryonic stage of adoption, wireless broadband is undergoing exponential growth.

| | Senegal | Cote d'Ivoire | Mali | Niger |
|---|---|---|---|---|
| Fixed broadband lines | 95,561 | 96,200 | 2,168 | 3,669 |
| Year of Introduction of wireless broadband | 2008 | 2012 | 2010 | 2011 |
| Number of wireless broadband connections | 447,786 | 10,187 | 763,209 | 23,758 |
| Wireless broadband penetration | 3.37 % | 0.05 % | 4.61 % | 0.14 % |

Table 1. Francophone West Africa: Broadband Adoption (2012)
Sources: Wireless Broadband (GSMA Intelligence); Senegal (ITU); Cote d'Ivoire (ATCI); Mali (ITU); Niger (ITU)

To assess the impact of broadband, this study relied on a structural model similar to the one used when assessing the impact of wireless telephony.

To offer a context for its own approach, this study first provides a brief literature review of established research surrounding the economic impact of telecommunications (Chapter 2). An overview of the Francophone West Africa economies (Chapter 3) follows and is complemented by an explanation of the key characteristics of the four countries' telecommunications markets (Chapter 4). A review of telecommunications' direct and indirect economic contributions follows (Chapter 5), along with a discussion of the study's methodology and findings. The policy implications derived from these findings conclude the study (Chapter 6).

## 2. Impact of Mobile Telephony and Broadband on the economy: a review of the literature

Whether driving innovation in more advanced economies or addressing the lack of traditional fixed-line services in emerging countries, mobile phones affect all economies regardless of their stage of development. As mobile infrastructure becomes a permanent social fixture, so do its effects on the market and the economy. A review of the literature indicates that mobile telephony and broadband access can lead to more informed markets, increased employment opportunities, and GDP growth.

Multiple micro-economic studies from emerging countries show that enhanced communication results in more efficient markets, which ultimately improve consumer welfare. For instance, in Kerala (India), the introduction of mobile telephony led to a more informed and demand-driven fishery market (Jensen, 2007). Similarly, in Niger, prices in the grain market fell, resulting in increased profits and, ultimately, consumer welfare improvements (Aker, 2008). Rural Ugandan banana farmers producing perishable crops benefitted as the costs of crop marketing decreased as a result of mobile coverage (Muto, 2008).

Mobile networks can also address lack of access to traditional services. In Kenya and Tanzania, the launch of financial services and micropayments via mobile phones reduced

both the cost of banking services and the transactional burdens, leading to a reduction of the countries' "unbanked" population. Similarly, the introduction of mHealth mobile applications in such countries as Ghana and Cape Verde resulted in more accessible, affordable, and higher quality healthcare services in developing countries (Kelly and Minges, 2012).[1]

In some instances, the introduction of mobile networks can lead to the development of new markets and services. When a region received wireless network coverage in South Africa, for example, employment significantly increased (Klonner and Nolen, 2010); likewise, in Malawi, female labor participation increased (Batziillis et al., 2010). On a related note, the mobile applications that assist with the job search and application process are particularly beneficial in instances of low digital literacy or where the employment process is largely informal (Donner, Gitau, and Marsden, 2011).[2] In many cases, the higher-quality jobs are listed online, where only those citizens with digital literacy skills and Internet access can apply for them.

Additionally, it is important to note that multiple studies (see Waverman, Meschi and Fuss, 2005; Shiu and Lam, 2008; Kathuria, Uppal and Mamta, 2009; Andrianaivo and Kpodra, 2011) find initial increasing returns to economic growth as a result of the "return to scale effect" when it comes to mobile telephony's effects on the economy. In other words, wireless telecommunications' economic impact is maximized once the infrastructure reaches a critical mass point, which in developed countries typically correlates with penetration. As Gruber and Koutroumpis (2011) show, mobile telephony's effects on GDP growth correlate with wireless penetration growth up until penetration rates reach 60%, at which point effects tend to subside.

Like mobile networks, broadband can also affect economic growth. Through the introduction of new services and applications, new forms of commerce, mass customization of products, reduction of excess inventories, and optimization of supply chains, growth in business revenue (Varian et al., 2002; Gillett et al., 2006), and growth in service industries (Crandall et al., 2007), broadband can positively impact output and employment.

While many studies that examine the relationship between broadband access and the economy focus on data from the United States, additional research has emerged confirming positive effects of broadband penetration growth in Germany (Katz et al., 2010) as well as in Brazil, Chile, India, Saudi Arabia, Indonesia, and the Dominican Republic (Katz, 2011a). That said, while all of these countries witnessed a significant employment increase, the growth varied widely. Explanations could include migratory trends (Crandall et al, 2007), local effects (Gillett et al., 2006), and industry sector differences (Shideler et al, 2007). For example, the new jobs that opened as a result of broadband tended to occur in

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[1] Kelly, Tim, and Michael Minges, Eds. *Maximizing Mobile*. Rep. The World Bank, 2012. Web. <http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGIE S/Resources/IC4D-2012-Report.pdf>.

[2] Donner, Jonathan, Shikoh Gitau, and Gary Marsden. "Exploring Mobile-only Internet Use: Results of a Training Study in Urban South Africa." *International Journal of Communication* 5 (2011): 574-97. *IJOC*. Web. 26 Jan. 2012. <http://ijoc.org/ojs/index.php/ijoc/article/view/750/543>.

the service industries, although some studies also found a presence in the manufacturing sector as well (Crandall et al, 2007). Only the lodging and food services industry saw a decline in employment opportunities, likely due to the strong capital / labor substitution process whereby the realized productivity gains led to a lower need for labor (Thompson and Garbacz, 2008).

Broadband can also make government services more accessible, reducing government expenditures and keeping citizens more informed, amongst other benefits. As Zenghelis (2011) found, by establishing more accountable institutions, all countries – particularly developing countries – can benefit from more "inclusive, efficient, and transparent" governance, which then spur total-factor productivity and overall prosperity.[3]

The effects of broadband introduction on the economy mimic the effects of infrastructure deployment. Beyond GDP growth, broadband can impact infrastructure investment (Katz et al., 2009; Katz et al, 2010a), productivity growth, and the elasticity of supply as well as household income. In the OECD countries, for instance, research has demonstrated that broadband adoption led to a significant rise in per capita GDP (Czernich et al., 2009; Koutroumpis, 2009; Katz et al., 2010). The countries with higher broadband penetration rates saw higher GDP growth rates (Koutroumpis, 2009). A study of ASEAN countries also concluded that broadband deployment positively impacts GDP growth (Ng, Lye, and Lim, 2013),[4] as did an examination of Indonesia and Malaysia (Katz, 2012a).[5] The same held true at a global level, where broadband adoption had less of an effect on economic growth in countries with lower broadband penetration rates (Katz, 2012a).

In sum, multiple studies looking at both advanced and emerging economies conclude that mobile network and broadband access have positive economic effects. Wireless access can result in a more efficient market, with benefits realized by both vendors and consumers. Wireless services can also address lack of access to other traditional services, such as banking or healthcare. These new services can even create new markets and increased employment opportunities, further spurring economic activity. Broadband access can also lead to job creation, as confirmed in studies examining multiple countries. Lastly, broadband access can also result in a rise in GDP, productivity growth, supply elasticity, and an increase in household income. While most studies tend to focus on developed economies, more recent studies offer evidence of these benefits in the case of emerging countries. This study will provide additional insights regarding the economic impact of telecommunications on an African region.

## 3. The economies of Francophone West Africa

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[3] Zenghelis, Dimitri. *The Economics of Network-Driven Growth*. Rep. Cisco, Jan. 2011. Web. <http://www.cisco.com/web/about/ac79/docs/Economics_NPG_FINALFINAL.pdf>.

[4] Ng, Tuan Hock, Chun Teck Lye, and Ying San Lim. "Broadband Penetration and Economic Growth in ASEAN Countries: A Generalized Method of Moments Approach." *Applied Economics Letters* 20.9 (2013): 857-62. Web. <http://www.tandfonline.com/doi/abs/10.1080/13504851.2012.754538?journalCode=rael20#preview>.

[5] http://www.itu.int/ITU-D/treg/broadband/ITU-BB-Reports_Impact-of-Broadband-on-the-Economy.pdf

The following section reviews the current state of the four countries studied. First, it provides a view of the commonalities between Senegal, Cote d'Ivoire, Mali, and Niger. Beyond highlighting these features, it then reviews each of the four economies in greater detail.

## 3.1. Economic Commonalities

Ranked amongst the poorest countries in the world, the economies of Senegal, Cote d'Ivoire, Mali, and Niger exhibit several common features. As all four depend largely on agriculture-based industries, unpredictable rainfall variations and droughts, floods, and other natural disasters subject the economies to instability. While the global economic downturn did affect these countries to some degree, national and regional political and economic crises have taken their own toll. Despite subdued global demand conditions, strong domestic demand allowed the four African economies to resume their robust growth trajectory in 2012 (and 2013 for Mali). Investments in both the resource and non-resource sectors supported much of this growth while high commodity prices encouraged investments in the natural resource sectors. Investments have also flowed to the service sectors - including telecommunications, transportation, and retail trade - further stimulating growth.

As shown in Table 2, GDP growth is predicted to continue across the four countries.

| Country | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Senegal | 4.1 | 2.6 | 3.7 | 4.0 | 4.6 | 4.7 |
| Mali | 5.8 | 2.7 | -1.2 | 4.8 | 5.9 | 6.0 |
| Niger | 8.0 | 2.3 | 11.2 | 6.2 | 6.1 | 5.0 |
| Cote d'Ivoire | 2.4 | -4.7 | 9.8 | 8.0 | 8.0 | 8.1 |

Table 2. Francophone West Africa: Annual % Change GDP at Market Prices ($2005)
Source: World Bank Global Economic Prospects (June 2013)

Present demand conditions coupled with an anticipated bolstering of global demand will sustain the future growth, and the four countries under study will likely experience an average growth rate of 6.0 %. A brief review of specific country economic conditions is provided in turn.

## 3.2. Senegal

Senegal is a sub-Saharan country with a large rural population (60%[6]) with limited natural resources. Its key export industries are commercial fishing, phosphate mining, and fertilizer production. Iron ore and oil exploration projects also contribute to the gross domestic product, as do tourism, services, and peanut production. Its economy depends on rainfall variations, which combined with a lack of strong monetary policy make Senegal vulnerable

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[6] World Bank Data

to changes in world commodity prices. Senegal also relies heavily on donor assistance, representing almost a quarter of its government spending in 2007[78].

While the Senegalese food and energy crisis of 2008 significantly affected the country's economy, recovery began in 2010 after the global economic upturn and a combination of domestic structural reforms. Gross domestic product (GDP) growth increased from 2.2% in 2009 to 4.2% in 2010, although it fell back to 2.6%[9] in 2011. This number recovered in 2012, reaching 3.7%, with projected growth of 4.3% and 5.1% for 2013 and 2014 respectively. These projections are based on future implementation of the government's socio-economic program and compliance with the IMF's Policy Support Instrument.[10]

In 2011 inflation reached 3.38% mainly as a result of higher energy prices, but dropped down to 1.42% in 2012[11] and hovered at 1.1% until July 2013[12]. Total imports of goods and services had steadily grown after 2001 reaching a peak of 53.8% of GDP in 2008 but experienced a sudden drop thereafter declining to 44% of GDP in 2010. Exports further fell to 24% in 2011, expanding the external balance of goods and services.

### 3.3. Mali

Mali has made strides in reducing its national-level poverty rate over the past decade, down to 43% in 2010 after reaching 56% in 2001.[13] That said, despite some progress, the country still suffered as a result of the global economic recession and regional crises. Further, Mali's own political instability could threaten future economic development, as could climate change, which poses a serious potential problem for the country's food and nutritional supply[14].

Mali's economy centers on the agricultural, livestock, and fishing sectors, which together employ 70% of the population and produce one-third of national GDP.[15] Naturally, the agriculture sector depends on rainfall, which subjects the economy to much instability and unpredictability as a result of such events as drought, floods, and erratic rainfall,[16] but even still, crop yields consistently fall well below their potential.[17] While the country does have natural mineral resources, it largely underexploits them and lacks adequate infrastructure to use them to its advantage.[18] Despite its development, the mining sector has not generated

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[7] Source: CIA Fact book, US State Department

[8] 2013 report lists 2007 as most recent (see Heritage Index of Econ Freedom); World Bank reported that Senegal received US$ 1.05B in 2011

[9] IMF http://www.imf.org/external/pubs/ft/weo/2012/01/index.htm

[10] African Economic Outlook: http://www.africaneconomicoutlook.org/en/countries/west-africa/senegal/

[11] World Bank

[12] http://www.tradingeconomics.com/calendar.

[13] World Bank Data http://data.worldbank.org/indicator/SI.POV.NAHC

[14] http://www.ruralpovertyportal.org/en/country/home/tags/mali

[15] Heritage Foundation http://www.heritage.org/index/country/mali

[16] Rural Poverty Portal http://www.ruralpovertyportal.org/country/home/tags/mali

[17] http://www.afriquejet.com/news/8405-grain-production-in-mali.html

[18] Heritage Foundation http://www.heritage.org/index/country/mali

national enterprises.[19] The economy has little diversification, with private-sector activity largely occurring outside of the formal sector.[20]

Even during the global recession, Mali continued to experience moderate GDP growth of approximately 5% between 2008 and 2010. In 2011, however, growth fell 50% to 2.73% from 2010, with a decline to -1.19% in 2012.[21] The country's political tensions between April 2012 and January 2013 – which also resulted in suspension of international aid - have largely influenced this economic downturn. [22] Despite these events, however, the government demonstrated fiscal discipline in 2012, resuming a relationship with the IMF in 2013 and subsequently obtaining Rapid Credit Facility in the amount of US$ 18 million.

Despite economic difficulties and declines in investment, the country has exhibited improvements in fiscal freedom and government spending (down to 23.2% of GDP).[23] The overall economic environment could improve if the state continues to enact regulatory reform that encourages business development without losing ground due to the aforementioned political instability.[24]

## 3.4. Niger

Niger's economy depends on subsistence crops, livestock, and uranium deposits, which are some of the world's largest. Combined, the service and agricultural sectors account for nearly 85% of Niger's GDP. The country will likely see a significant increase in oil production, refining, and exports through 2016, although oil revenue to the government has fallen below the budgeted level. Niger currently has a crude oil export project under development, and the country will likely benefit in coming years from increased economic diversification. In 2013, the UN ranked Niger last on its list of 187 countries measured in the Human Development Index, a report that takes such factors as education, health, and income dimensions into account.[25] High levels of population growth coupled with drought and desertification can largely explain the nation's suffering economy, but the governmental implementation of an economic development program that focuses on increasing infrastructure spending could offer future relief.

The global recession hit the Nigerien economy hard, with GDP growth falling from 9.59% in 2008 to -0.91% in 2009 and then -7.96% in 2010. This trend seems to be reversing, however, with GDP growth reaching 11.2% in 2012.[26] Foreign Direct Investment (FDI) in Niger has increased significantly in recent years, with FDI as a percent of GDP more than doubling from 5.2% in 2008 to 12.0% in 2009, reaching 16.8% in 2011. FDI inflow

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[19] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/mali/

[20] Heritage Foundation http://www.heritage.org/index/country/mali

[21] World Bank Data http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

[22] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/mali/

[23] Heritage Foundation http://www.heritage.org/index/country/mali

[24] Heritage Foundation http://www.heritage.org/index/country/mali

[25] United Nations http://www.un.org/apps/news/story.asp?NewsID=44372#.UkLr6M0jv48

[26] World Bank Data http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

exceeded US$ 1 billion in 2011, up from just US$ 281 million in 2008. FDI finances Niger's current account deficit, as do capital grants, which will comprise an average 17% of exports throughout the next 20 years. The IMF predicts that the country's current account deficit will likely improve as a result of increased petroleum production.

Meanwhile, the IMF predicts that Niger's public debt exposure will rise significantly as the government increases its involvement in natural resource projects. As a result, public external debt is expected to increase from 24% of GDP in 2012 to 33.5% in 2013. Because private external debt will in turn decrease by 60%, total external debt should not be affected. Further, the rate of external public debt accumulation will likely remain stable.

## 3.5. Cote d'Ivoire

Cote d'Ivoire experienced a time of economic growth stimulated by coffee and cocoa production in the 1960s, but the early 1980s and late 1990s showed a significant decline in growth and subsequent increase in poverty.[27] As a result, the income gap widened, increasing tension within the country that led to an eventual civil war in 2002, which only exacerbated the country's economic instability.

That said, the country has experienced better than projected economic recovery, seeing a 9.8% rise in economic activity in 2012.[28] Increased political, social, and institutional stability in 2012 combined with a renewed interest in infrastructure upkeep led to an improvement in Cote d'Ivoire's economy, which saw 8.6% growth in GDP in 2012, compared to the negative growth (-4.73%) in 2011.[29] Forecasts for the upcoming years estimate an ongoing GDP growth in the range of 8.0%. This growth will only occur, however, if the government continues its efforts in strengthening the country's social cohesion and business climate and in supporting the emerging private sector.[30]

The world's largest producer of cocoa,[31] the Republic of Cote d'Ivoire suffers from extremely volatile global commodity prices.[32] If fully exploited, the country's natural resources could increase agricultural output while simultaneously offering more labor opportunities.[33] Challenges to efficient natural resource management include weak ties between the companies and other sectors of the economy as well as inadequate transparency relating to the arrangements between the government and the oil companies.[34]

The significant increase in investment-related imports coupled with efforts to strengthen the economy resulted in a larger budget deficit in 2012, and the external account recorded a

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[27] Rural Poverty Project http://www.ruralpovertyportal.org/country/home/tags/cote_divoire

[28] IMF http://www.imf.org/external/pubs/ft/scr/2013/cr13171.pdf

[29] IMF, World Bank Data

[30] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/cote-divoire/

[31] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/cote-divoire/

[32] Rural Poverty Portal http://www.ruralpovertyportal.org/country/home/tags/cote_divoire

[33] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/cote-divoire/

[34] African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/cote-divoire/

deficit of approximately 2% of GDP in 2012, the country's first deficit in five years. Foreign direct investment – which accounted for 1.43% of GDP in 2012 - helped in part to finance this deficit. The state does not discriminate against foreign investors, but investment lags as a result of capital controls and foreign exchange restrictions. Barriers to trade, including a 7.3% trade-weighted average tariff, further discourage international trade.

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In the context of the Francophone West African economic conditions, and based on the experience in the emerging world, telecommunications infrastructure can play an important role. On the economic side, telecommunications can:

- Increase the inter-linkages among national enterprises
- Facilitate exports
- Improve productivity of small farmers by enhancing their access to inputs while facilitating market reach
- Serve as an underlying network that would foster financial inclusion of a population marginalized from banking services
- Deliver training resources, thereby supplementing the pre-existing educational system

From a social standpoint, both wireless telephony and broadband should improve social inclusion of rural populations and enhance welfare of the urban poor.

## 4.   The Telecommunications Industry in Francophone West Africa

### 4.1. Telecommunications demand

The telecommunications sector of all four countries grew rapidly over the last five years, primarily driven by the adoption of mobile telephony. As of year-end 2012, of the four countries examined, Senegal (87.51%), Mali (89.55%), and Cote d'Ivoire (87.15%) all display mobile penetration rates far above the West Africa regional average of 71.17%. At 32.42%, however, Niger lags behind, but even so has still experienced dramatic mobile sector growth. The number of mobile subscriptions in Niger grew exponentially between 2004 and 2012, reaching 3.3 million mobile subscriptions by year-end 2012, up from just 82,000 in 2004.

|                | 2008  | 2009  | 2010  | 2011  | 2012  | 2Q2013 |
|----------------|-------|-------|-------|-------|-------|--------|
| **Senegal**    | 45.72 | 57.00 | 67.11 | 73.25 | 87.51 | 92.68  |
| **Cote d'Ivoire** | 54.55 | 68.14 | 79.03 | 86.06 | 87.15 | 92.45  |
| **Mali**       | 23.78 | 29.92 | 48.41 | 68.32 | 89.55 | 99.58  |
| **Niger**      | 13.13 | 17.36 | 23.65 | 29.52 | 32.42 | 33.58  |
| **Average**    | **34.29** | **43.10** | **54.55** | **64.29** | **74.16** | **79.57** |

Table 3. Francophone West Africa: Mobile Telephony Penetration (in percentage of population)
Sources: ITU; GSMA Intelligence

In another case of exponential growth, the number of mobile connections in Mali has grown substantially, up from just 406,000 in 2004 to more than 18.1 million in 2013.

In terms of mobile penetration, when compared to other West African countries, Mali ranks fourth of the fifteen countries, while Senegal remains fifth, Cote d'Ivoire sixth, and Niger last (see figure 1).
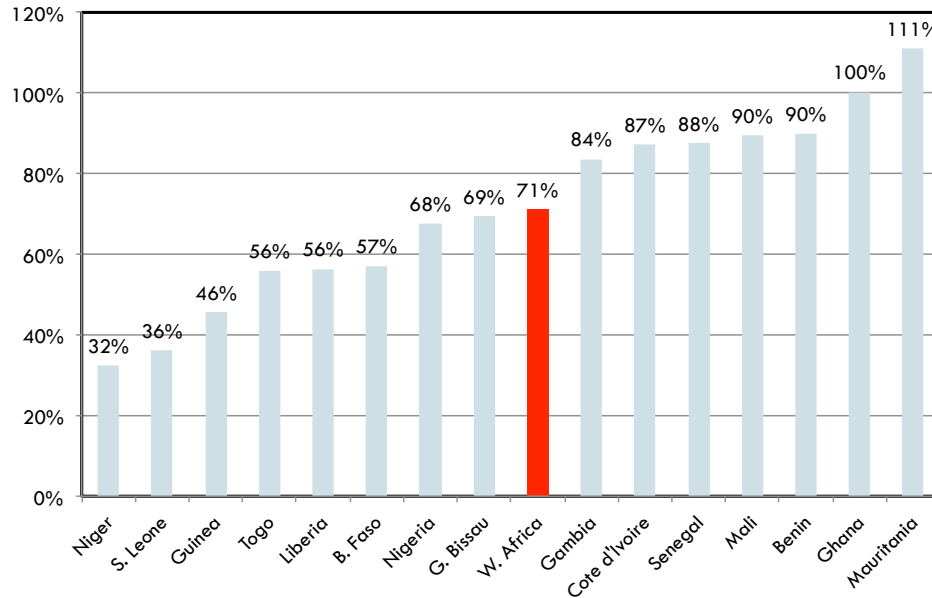


Figure 1. West Africa: Mobile Telephony Penetration (%)
Source: GSMA Intelligence

Meanwhile, although its fixed lines have not experienced the same exponential growth rates, this region does not exhibit as great a homogeneous fixed-mobile substitution dynamic as that seen in many other emerging countries (see table 4).[35]

| | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| **Senegal** | 237.7 | 278.8 | 341.8 | 346.4 | 338.2 |
| **Cote d'Ivoire** | 276.9 | 278.0 | 265.0 | 264.0 | 267.9 |
| **Mali** | 77.0 | 71.0 | 80.0 | 105.0 | 112.0 |
| **Niger** | 64.73 | 76.34 | 83.38 | 85.35 | 100.54 |

Table 4. Francophone West Africa: Wireline Access Lines (in '000)
Sources: Senegal and Niger (ITU); Cote d'Ivoire (Informa); Mali (AMRTP)

In Mali and Niger, fixed-mobile substitution is almost non-existent. For example, the number of fixed access lines in Mali has nearly doubled over the past eight years, up from 62,000 at the start of 2004 to 112,000 at the end of 2012. Even since the introduction of 3G services, the number of fixed lines has increased by 13.6%. Similarly, in Niger, while wireless has experienced a dramatic increase in subscriptions, so too have fixed-lines, which increased more than 400% between 2004 and 2012. Up until 2005, fixed-lines experienced very little growth, but early 2006 commenced a notable incline, with the number of fixed-line subscriptions nearly tripling in just three years. This growth has

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[35] See the example of Latin American countries.

continued through present, and the number of fixed-line subscriptions increased by 13% in 2012.

On the other hand, in Senegal, fixed-mobile substitution effects took place after the quick adoption of mobile services, resulting in 21% drop in fixed line services during 2007-2009. This three-year drop in fixed line subscribers lasted until the second quarter of 2009. Similarly, in Cote d'Ivoire, the number of subscriptions grew from 247,573 at the end of 2007 to 276,000 at the end of 2008. After this spike, however, the number fell substantially to 265,000 subscriptions by the end of the year. Since this decline, the number of fixed subscriptions has remained stable, ending 2012 at 267,997.

Fixed broadband remains consistently underdeveloped across all four countries.

|  | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| Senegal | 47,358 | 58,720 | 78,647 | 92,713 | 95,561 |
| Cote d'Ivoire | 40,000 | 50,000 | 71,000 | 71,000 | 96,200 |
| Mali | 2,661 | 3,009 | 2,314 | 2,367 | 2,168 |
| Niger | 617 | 1,000 | 1,500 | 2,114 | 3,669 |

Table 5. Francophone West Africa: Fixed Broadband Connections
Source: Senegal, Niger and Mali (ITU); Cote d'Ivoire (Informa)

On the other hand, 3G services have played a role in driving an emerging broadband market in some of the countries, although the technology has not yet caught momentum throughout the entire region.

|  | 2008 | 2009 | 2010 | 2011 | 2012 | 2Q2013 |
|---|---|---|---|---|---|---|
| Senegal | --- | 5,067 | 35,591 | 188,362 | 447,786 | 631,536 |
| Mali | --- | --- | 67,061 | 217,096 | 763,209 | 1,229,741 |
| Cote d'Ivoire | --- | --- | --- | --- | 10,187 | 42,900 |
| Niger | --- | --- | --- | 2,658 | 23,758 | 37,851 |

Table 6. Francophone West Africa: Wireless Broadband Connections
Source: GSMA Intelligence

Varying stages of diffusion of wireless broadband reflect the different points in time at which the technology has been launched. For example, 3G licenses in Cote d'Ivoire were not awarded until March 2012 while services in Senegal were launched in 2009, and in Mali in May 2010.

The deployment of additional long haul transmission cables and a consequent reduction in prices could further stimulate broadband penetration rates and demand across the region. In Cote d'Ivoire, for instance, the high costs of international bandwidth and limited access to the country's only international fiber optic submarine cable have stalled growth of the Internet and broadband market.[36] At the same time, the country already has a national backbone network of more than 20,000 km of fiber optic cable, which could accelerate the

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[36] Source: Yahoo Finance http://finance.yahoo.com/news/research-markets-cote-divoire-ivory-153300886.html

development of a healthy broadband market. In Niger, the deployment of multiple long haul transmission links is expected to meet growing demand for the services, however, by making Internet and telephony more affordable and accessible.

Similarly, the launch of services requiring a wireless connection, like Orange's Mobile Money, and the heightened focus on targeting underserved segments of the population will act as further stimulus of growth of wireless broadband adoption.

## 4.2. Telecommunications supply

As market competition, mobile adoption, and mobile usage in Francophone West Africa grew, so did industry revenues. Further, operators have expanded their reach with an increased focus on previously underserved segments of the population, offering less expensive services, plans, and handsets. At the same time, while these factors contributed to revenue growth, they also led to the decline in mobile ARPU that resulted in its stabilization. As 3G gains momentum, however, revenues could likely follow another ascent (see table 7).

| Country | 2008 | 2009 | 2010 | 2011 | 2012 |
|---|---|---|---|---|---|
| **Senegal** | $ 1,364 | $ 1,360 | $ 1,398 | $ 1,431 | $ 1,503 |
| **Mali** | $ 494 | $ 513 | $ 563 | $ 557 | --- |
| **Cote d'Ivoire** | $ 1,520 | $ 1,540 | $ 1,540 | $ 1,580 | $ 1,674 |
| **Niger** | $ 148 | $ 186 | $ 235 | $ 317 | $ 373 |

Table 7. Francophone West Africa: Telecommunications Industry Revenues (in US$ million)
Source: UIT

Total service revenues in Senegal have seen a seven-fold increase since 2001, and have grown US$ 100 million since 2010, reaching a total of US$ 1.5 billion. This growth in revenue reflects the rise in mobile adoption and usage. The increase since 2010 is comparatively slight, however, and does not match the previous momentum between 2002 and 2008, when revenues increased from just US$ .25 million. The stabilization of revenue growth is primarily due to the decline in mobile ARPU resulting from increased competition. Nevertheless, the data shows that the telecommunications sector growth is now aligned with the GDP growth trend.

Over the course of the past 15 years, total service revenues in Mali have multiplied nearly ten-fold from US$ 56.34 million in 1996 to US$ 557.40 million in 2011. The largest jump occurred in 2003 and 2004 – the same time as Orange's launch and right as mobile services began gaining momentum - when revenues increased by 49.79% and 55.85% respectively. In 2010, the same year as the 3G launch, the Malian telecommunications industry saw its highest revenues to date, US$563.32 million, but saw a negative growth in revenues (-1.05%) in 2011. Following the resolution of the country's political crisis and overall improvement in the Malian economy, however, reports from both Maroc Telecom (Sotelma) and Orange (Sonatel) show a return to growth and an increase in both

subscribers and sales. [37] [38] As 3G services gain momentum, a further increase in revenues could likely follow. From 2001 – 2004, revenue growth within the Malian telecom market well surpassed that of the country's change in real GDP. By 2009, the numbers were nearly equal (3.83% for telecom, 4.46% for GDP). In 2011, when telecommunications revenue fell by -1.05%, real GDP grew by 2.73%. While the increase in mobile phone penetration has largely contributed to sector revenue growth, the decline in mobile ARPU resulted in the stabilization and drop in sector revenue.

Despite the relatively low penetration rates in Niger, the growth in services throughout the sector fuelled a dramatic increase in total service revenues. Over the course of 15 years, revenues grew from US$ .017 billion in 1996 to US$ .317 billion in 2011, due largely to the adoption of mobile services. Since 2000, growth in the telecommunications sector has outperformed the country's real GDP growth, peaking in 2002 at 58.43% (compared to Real GDP growth of 3.00%) and stabilizing by 2011 at 25.92% (compared to Real GDP growth of 2.29%). During this time frame, both prepaid and blended ARPU stayed relatively flat.

Total service revenues in Cote d'Ivoire have grown nearly nine-fold over the course of the past 15 years, up from US$ 0.18 billion in 1996 to US$ 1.58 billion in 2011. Despite revenue growth of more than 25% in 2008 alone, since this point, total service revenues have remained relatively flat, growing just 4% over the course of the last 3 years. As a result of this slow down, revenue growth of the telecommunications sector dipped below growth of real GDP, but has since gained momentum. The change in telecommunications sector revenue reflects the dramatic growth of mobile telephony. At the same time, with so much competition in the market, prepaid ARPU increased slightly during 2009, but blended ARPU has fallen through present.

In general terms, the competitive dynamics of the telecommunications industry in the region are quite intense. With the exception of Mali, which only has two operators, all other countries under study have at least three players. Furthermore, in all countries, the HHI index of wireless market concentration is evolving towards higher competitive levels, with Cote d'Ivoire being the most fragmented market in the region.

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[37] Source: Reuters, Maroc Telecom
http://www.reuters.com/article/2013/07/24/idUSnHUGdczh+70+ONE20130724
[38] Source: TeleGeography

| Country | Market Structure Metrics | 2008 | 2009 | 2010 | 2011 | 2012 | 2Q2013 |
|---|---|---|---|---|---|---|---|
| **Senegal** | Number of Wireless Telephony Players | 2 | 3 | 3 | 3 | 3 | 3 |
| | Wireless Telephony Herfindahl Hirshman Index | 5,489 | 5,384 | 4,634 | 4,991 | 4,603 | 4,506 |
| | Number of Fixed Broadband Players | 2 | 2 | 2 | 2 | 2 | 2 |
| **Mali** | Number of Wireless Telephony Players | 2 | 2 | 2 | 2 | 2 | 2 |
| | Wireless Telephony Herfindahl Hirshman Index | 6,847 | 6,916 | 5,690 | 5,183 | 5,153 | 5,147 |
| | Number of Fixed Broadband Players | 1 | 1 | 1 | 1 | 1 | 1 |
| **Cote d'Ivoire** | Number of Wireless Telephony Players | 4 | 5 | 5 | 5 | 6 | 6 |
| | Wireless Telephony Herfindahl Hirshman Index | 3,119 | 2,644 | 2,791 | 2,869 | 2,850 | 2,844 |
| | Number of Fixed Broadband Players | 1 | 2 | 2 | 2 | 2 | 2 |
| **Niger** | Number of Wireless Telephony Players | 4 | 4 | 4 | 4 | 4 | 4 |
| | Wireless Telephony Herfindahl Hirshman Index | 5,052 | 4,378 | 3,917 | 3,765 | 3,815 | 3,593 |
| | Number of Fixed Broadband Players | 1 | 1 | 1 | 1 | 1 | 1 |

Table 8. Francophone West Africa: Telecommunications Industry Market Structure
Source: GSMA Intelligence; Country Regulators

In Senegal, local incumbent Sonatel - now Orange Senegal – controlled the Senegalese mobile market until 1999 when a second operator – Tigo – entered. In 2009, Expresso, the third operator, launched services. With a 62.85% share as of 2012, Sonatel continues to dominate the market. Tigo claims 24.30% of the customer base and Expresso the remaining 12.85%. Despite the apparent stability of market shares, competitive intensity in the wireless market has increased since 2010.

Incumbent Sotelma controlled the Malian mobile market until Orange Mali entered as the second operator and launched services in 2003 after the Malian government offered a fixed-line, mobile, and Internet services license. In February 2013, the government offered a third license to the Planor-Monaco Telecom International consortium, which will operate through the Malian company Alpha Telecommunication Mali SA (Atel-SA). In September 2013, however, it was announced that the operator could lose the license due to non-payment. At present (2013), with 10.4 million mobile customers, Orange Mali leads the market with a 57 % market share.[39]

Niger has four mobile services providers: Airtel, Moov, Orange, and SahelCom. In 2000, the country's telecoms regulator ARM awarded GSM licenses to Celtel (now Airtel Niger), Telecel (now Moov Niger), and SahelCom. Seven years later, the regulator awarded a new "global license" to Orange for fixed, wireless, and Internet services.[40] Despite entering the mobile market last, Orange boasted a 28% market share (1.67 million active customers) in mid-2013, second only to Airtel. Its mobile network covers 75% of the population. Orange remains the country's mobile broadband market leader.

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[39] Orange http://www.orange.com/en/group/global-footprint/countries/Group-s-activities-in-Mali
[40] TeleGeography

Cote d'Ivoire's above average mobile penetration rates are, in part, a result of the country's highly competitive mobile sector. While MTN and Orange lead the market,[41] the country is home to a total of six mobile operators, including Moov-Atlantic (Etisalat), KoZ (Comium Group), and Oricel Green Network (LAP Green). In April 2012, Mobile Cafe launched its network, as the first wholly-domestically owned GSM provider.[42] In March 2012, L'Agence des Telecommunications de Cote d'Ivoire (ATCI) awarded the country's first 3G license to MTN Cote d'Ivoire for US$ 11.9 million.[43] Additional licenses were allocated to Moov and Orange, which was the first operator to launch 3G services.[44]

## 5. The economic impact of telecommunications in Francophone West Africa

The impact of telecommunications on the economies of the Francophone West African countries needs to be assessed first in terms of the sector's direct impact, as measured by its contribution to the GDP and the employment opportunities generated by its operators and their local suppliers. On the other hand, telecommunications must also be viewed as a general purpose technology, meaning that it has an additional impact resulting from the positive externalities as reviewed in chapter 2. This chapter will assess the direct and indirect contribution that telecommunications has had thus far on economic development in Francophone West Africa.

### 5.1. Direct economic contribution

The direct economic effects of telecommunications witnessed in the four West African Francophone countries under study are sizable. Total revenues generated by the telecommunications industries amount to US$ 4,107 million, which represents 7.3% of total GDP (see table 9).

|  | Revenues | GDP | Percent of GDP | Year |
|---|---|---|---|---|
| **Senegal** | $1,503 | $14,160 | 10.6% | 2012 |
| **Cote d'Ivoire** | $1,674 | $24,680 | 6.8% | 2012 |
| **Mali** | $557 | $10,656 | 5.2% | 2011 |
| **Niger** | $373 | $6,568 | 5.7% | 2012 |
| **Total** | **$4,107** | **$56,064** | **7.3%** | |

Table 9. Francophone West Africa: Telecommunications Industry Revenues
Source: Senegal (Comptes Nationaux, Sonatel, Hot Telecom, World Bank); Cote d'Ivoire (ATCI; GSMA; IMF); Mali (AMRTP); Niger (GSMA; Pyramid Research)

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[41] Source: Yahoo Finance http://finance.yahoo.com/news/research-markets-cote-divoire-ivory-153300886.html

[42] Source: Oxford Business Group

[43] TeleGeography

[44] Source: http://www.oxfordbusinessgroup.com/economic_updates/côte-d'ivoire-evolution-dans-le-secteur-de-la-téléphonie-mobile

In addition to its direct monetary contribution to the economy, the industry also fuelled job creation. In 2011-12, the telecommunications industry generated 8,100 direct jobs (by the respective operators) and an estimated 152,000 indirect jobs (by providers of inputs to the industry) within the four countries (see table 10).

| | Direct jobs | Indirect Jobs | Direct and Indirect Jobs (*) | Country Workforce | Percent of Total Workforce | Year |
|---|---|---|---|---|---|---|
| Senegal | 2,795 | 55,000 | 57,795 | 8,847,917 | 0.7 % | 2011 |
| Cote d'Ivoire | 3,399 | 62,315 | 65,714 | 12,936,157 | 0.5 % | 2012 |
| Mali | 1,133 | 20,772 | 21,905 | 7,666,337 | 0.3 % | 2011 |
| Niger | 759 | 13,910 | 14,669 | 9,866,363 | 0.1 % | 2012 |
| Total | 8,086 | 151,997 | 160,083 | 39,316,774 | 0.4 % | |

Table 10. Francophone West Africa: Telecommunications Industry Direct and Indirect Employment
Source: Senegal (Comptes Nationaux, Sonatel, Hot Telecom, World Bank); Cote d'Ivoire (ATCI; GSMA; IMF); Mali (AMRTP); Niger (GSMA; Pyramid Research); total workforce: World Bank
(*) Estimated

The sum of all jobs created by the telecommunications industry represents 0.4 % of the total workforce of all four countries.

Beyond its direct contribution, the telecommunications industry also has an indirect effect on economic growth. The next section assesses the positive externalities of telecommunications in all four Western Africa Francophone economies.

## 5.2. Indirect economic contribution

As anticipated in the introduction, given the differing penetration rates exhibited by mobile telephony and broadband, the analysis of economic impact of both technologies will be conducted through two different econometric models.

Regional and country-level statistical studies of ICT's impact in emerging economies usually suffer from the lack of microdata as the institutions and technical committees do not always collect information in a relatively frequent and consistent manner. This situation introduces a degree of complexity in the data mining phase. This study relied on several data bases: GSMA Intelligence, International telecommunications Union (ITU), Informa, Pyramid Research, and information provided by the local regulators in each of the four countries.

In addition, data from the operators was compiled. Telecommunications' costs are provided by the operators and, in the case of wireless, are disaggregated in pre- and post-paid ARPUs. Local operators also provide market performance metrics (capex, revenues, etc.). Other macroeconmic metrics (GDP, fixed capital formation, education, labor force etc) are available from the World Bank and IMF. Data sources are included in appendix A.

## 5.2.1. Mobile telephony economic impact

To measure the indirect economic impact of mobile telephony on GDP, a structural model consisting of four equations was constructed: an aggregate production function modeling the economy and, subsequently, three demand, supply, and output functions. The last three functions model the wireless market operation and, controlling for the reverse effects, the actual impact of the infrastructure is estimated. In the production function, GDP is linked to the fixed stock of capital, labor and the mobile infrastructure proxied by mobile penetration. The demand function links mobile penetration to the average consumption propensity of individuals proxied by GDP per capita, the cost of a basic mobile service and the competition in the mobile market, measured by the HHI index. The supply function links the aggregate mobile revenue to mobile price levels proxied by ARPU (Average Revenue per User), the industry concentration index of the mobile market (HHI) and GDP per capita. The infrastructure equation links annual change in mobile penetration to mobile revenues, used as a proxy of the capital invested in a country during one year.

The econometric specification of the model is as follows:

Aggregate Production function:
$$GDP_{it} = a_1 K_{it} + a_2 L_{it} + a_3 Mob\_Pen_{it} + \varepsilon_{1it} \qquad (1)$$

Demand function:
$$Mob\_Pen_{it} = b_1 MobPr_{it} + b_2 GDPC_{it} + b_3 HHI_{it} + \varepsilon_{2it} \qquad (2)$$

Supply function:
$$Mob\_Rev_{it} = c_1 MobPr_{it} + c_2 GDPC_{it} + c_3 HHI_{it} + \varepsilon_{3it} \qquad (3)$$

Output function:
$$\Delta Mob\_Pen_{it} = d_1 Mob\_Rev_{it} + \varepsilon_{4it} \qquad (4)$$

These models found that, with the exception of Niger, mobile telephony has affected the Francophone West African economies significantly during the last 7 years (2005-2012). Specifically, the model results show that as mobile penetration increases, so does GDP, albeit at different levels (see table 11).

| | Variables | Senegal | Cote d'Ivoire | Mali | Niger |
|---|---|---|---|---|---|
| ***Growth (GDP)*** | Labor force (L) | 0.366*** | 0.375*** | 0.331*** | -0.452*** |
| | Fixed Capital Stock (K) | 0.785*** | 0.135*** | 0.333*** | 0.333*** |
| | Mob Penetration (Mob_Pen) | 0.061* | 0.059* | 0.063** | 0.017 |
| | Constant | - | - | - | 13.081*** |
| **Demand (Mob_Pen)** | GDPC (GDPC) | 5.365*** | -1.441 | 4.777*** | 1.427 |
| | Mob. Price (MobPr) | .6223 | -1.132** | 0.039 | 0.804*** |
| | Market Concentration (HHI) | -.0002 | -0.252 | -0.001*** | -0.001*** |
| | Constant | -39.324*** | 25.210** | -12.574*** | -7.663 |
| **Supply (Mob_Rev)** | ARPU (ARPU) | 1.594*** | -0.075** | 1.002*** | 1.871*** |
| | GDPC (GDPC) | 5.750*** | 1.016*** | 4.822*** | 1.814* |
| | Market Concentration (HHI) | -.0005*** | -0.189*** | -0.001*** | -0.001*** |
| | Constant | -36.806*** | 13.091 | -12.010*** | -6.259 |
| **Output (ΔMob_Pen)** | Mob Revenue (Mob_Rev) | 0.539*** | 0.477* | 1.659*** | -0.005 |
| | Constant | 9.545*** | 2.360 | -35.252*** | -5.124*** |
| **Controls** | Year Effects | YES | YES | YES | YES |
| | Quarter Effects | YES | YES | YES | YES |
| | Operator Effects | YES | YES | YES | YES |
| **R2** | Growth | 0.99 | 0.99 | 0.99 | 0.99 |
| | Demand | 0.62 | 0.37 | 0.96 | 0.74 |
| | Supply | 0.90 | 0.88 | 0.88 | 0.86 |
| | Output | 0.23 | 0.03 | 0.54 | 0.01 |

Table 11. Francophone West Africa: Country-Specific Wireless Economic Impact Model Results
Source: TAS analysis

To reiterate, according to the country specific models, an increase of one percent in wireless penetration could trigger the following contributions to each country's GDP growth rate:

• Senegal: 0.061 % (statiscally significant at 5% level)
• Cote de'Ivoire: 0.059 (statiscally significant at 5% level)
• Mali: 0.063 (statiscally significant at 10% level)
• Niger: 0.017 (no statistical significance)

The lack of statistical significance of the impact of wireless telephony on Niger's GDP growth is due to the limited adoption of the technology over the period between 2005 and 2013 (average wireless penetration: 20.55%). This was confirmed by running a simple Cobb-Douglas production function, which includes mobile telephony as one of its terms (appendix B).

In addition, the results of specific functions allow to highlight key drivers of future impact (see table 12).

| Country | Further analysis |
|---------|------------------|
| Senegal | • Capital deepening has an unusual high impact on economic growth (coefficient of 0.785 versus 0.1349 for Cote d'Ivoire)<br>• Incomes are crucial for adoption and investments (coefficient: 5.635), which indicate that affordability remains a critical barrier for demand<br>• Competition has a positive impact on investments (coefficient: -0.0005 and significant) but not on adoption (not significant) |
| Cote d'Ivoire | • Wireless prices affect both the demand (coefficient: -1.131) and supply of services (coefficient: -.07456)<br>• Competition has positively affected investments (coefficient: -.18853)<br>• Incomes seem to critically affect operator revenues (coefficient: 1.0159) while not deterring adoption of services (coefficient: -1.441) |
| Mali | • Incomes are crucial for adoption (coefficient: 4.777) and investments (coefficient: 4.8222)<br>• Competition has a positive impact on investments (coefficient: -.0001) and on adoption (coefficient: -.0001) |
| Niger | • Low levels of skills and education hamper adoption and its impacts (coefficient: -.45219)<br>• Competition has already significant positive effects on adoption (coefficient: -.0012) and investments (coefficient: -.0012) |

Table 12. Francophone West Africa: Analysis of Coefficients in Country-specific Models
Source: TAS analysis

Furthermore, looking at the results in light of the growth impact curve of Gruber and Koutroumpis' model (2011), each of these countries, with the exception of Niger, displayed higher than average coefficients, indicating an acceleration of impact.
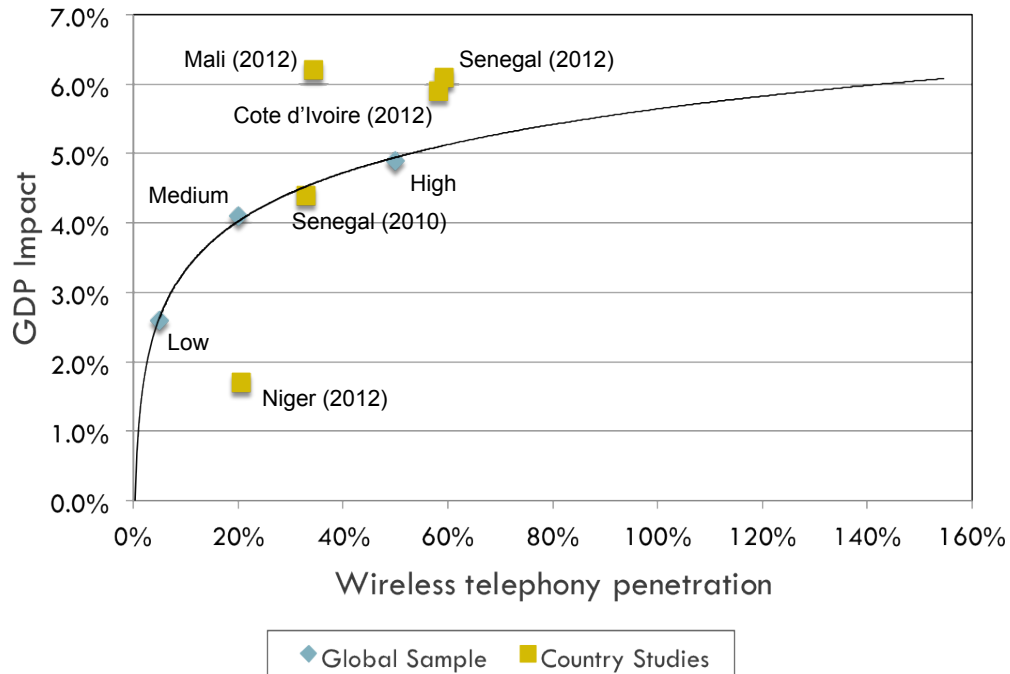
Figure 2: Wireless Telephony Impact: Country Model Results Versus Global Sample Estimates
Note: Estimate based on fitted line of previous studies
Source: TAS analysis

While the vast heterogeneity experienced in the global sample of Gruber and Koutroumpis' study could partially explain these higher coefficients, it could also be that the economic contribution of mobile telephony is accelerating due to the development of new services that rely on telecommunications to reach consumers. We consider, in particular, financial services like mobile money that rely on text messaging.

Further, looking at the results in light of the logarithmic growth impact curve of Gruber and Koutroumpis (2011), Niger exhibits an unusually low coefficient of economic impact (0.017), well below the function estimated by Gruber and Koutroumpis' model based on a sample of 150 countries, and significantly below its peers of the Francophone zone. That said, when considering the forecast of wireless telephony penetration in Niger for the next four years, one can hypothesize that the economic impact model specified on future data would start to yield significant results. In four years, wireless telephony in Niger will reach 48%. Based on the results of studies conducted for the other countries in the Francophone zone, the indirect economic effect of the technology will be proven.

In order to anticipate the potential economic impact of wireless telephony in Niger, the researchers integrated all country observations within a single model, which yields the following results (see table 13):

| | Variables | Four-Countries |
|---|---|---|
| **Growth (GDP)** | Labor force (L) | -0.383*** |
| | Fixed Capital Stock (K) | 0.891*** |
| | Mob Penetration (Mob_Pen) | 0.028*** |
| | Constant | 9.887*** |
| **Demand (Mob_Pen)** | GDPC (GDPC) | -0.656 |
| | Mob. Price (MobPr) | -0.468* |
| | Market Concentration (HHI) | 0.0017*** |
| | Constant | 10.380 |
| **Supply (Mob_Rev)** | ARPU (ARPUit) | 0.099*** |
| | GDPC (GDPCit) | 1.423*** |
| | Market Concentration (HHI) | -0.0002*** |
| | Constant | 9.688*** |
| **Output (ΔMob_Penit)** | Mob Revenue (Mob_Rev) | 0.551 |
| | Constant | 1.174 |
| **Controls** | Year Effects | YES |
| | Quarter Effects | YES |
| | Operator Effects | YES |
| **R2** | Growth | 99.99% |
| | Demand | 61.29% |
| | Supply | 93.55% |
| | Output | 7.77% |

Table 13. Francophone West Africa: Four-country integrated model results
Source: TAS analysis

According to the four-countries model, an increase of one percent in wireless penetration could trigger 0.028 percent contribution to each of the countries GDP growth rate. The model is specified with a high degree of controls (country, year, quarter, and operator) and still yields statistically significant coefficients (to the 0.1%).

By relying on the country specific coefficients for Senegal, Mali, and Cote d'Ivoire, and the four-country coefficient for Niger, the actual contribution of wireless technology to each of the countries' GDPs was estimated. For this purpose, the compound annual growth rate of wireless penetration between 2005 and 2013 (formula 5) was multiplied by the coefficient of economic impact derived from the econometric model presented in Tables 4 and 13 in the case of Niger (Formula 6):

CAGR = (Wireless penetration 2Q2013 -Wireless penetration 4Q2005 ) ^ (1/7.5)-1   (5)

Impact of wireless on GDP (2005-2013)= CAGR*Coefficient of Impact                (6)

Following this, the annual impact of wireless on a country's GDP was divided by the CAGR of GDP (formula 7) and multiplied by the incremental GDP between 2005 and 2012 (formula 8).

% impact of wireless to GDP growth = Annual impact of wireless on GDP / CAGR GDP (2005-2012)   (7)

Impact of Wireless on Incremental GDP = Incremental GDP (2012-2005) * % impact of wireless to GDP growth  (8)

By dividing the total impact of wireless on incremental GDP growth between 2012 and 2005 by the number of years, the annual impact was estimated for each country (see table 14).

| Item | Component | Senegal | Cote d'Ivoire | Mali (*) | Niger (**) |
|------|-----------|---------|---------------|----------|------------|
| 1 | Annual contribution of wireless telephony to GDP growth (for every 10% increase in wireless penetration) | 0.61 | 0.59 | 0.63 | 0.28 |
| 2 | Wireless telephony penetration 2Q2013 | 92.68 % | 92.45 % | 94.78 % | 32.74% |
| 3 | Wireless telephony penetration 4Q2005 | 15.70 % | 12.91 % | 12.38 % | 12.33% |
| 4 | CAGR Wireless telephony penetration | 26.71 % | 30.01 % | 40.39 % | 27.65% |
| 5 | Annual impact of wireless on GDP | 1.63 % | 1.77 % | 2.54 % | 0.77% |
| 6 | CAGR GDP per capita (2005-2012) | 7.21 % | 6.05 % | 3.56 % | 7.72% |
| 7 | Percent contribution of wireless telephony to GDP growth | 22.60 % | 29.27 % | 71.47 % | 10.03% |
| 8 | Incremental GDP (2005-2012) ('000'000) | US$ 5,461 mm | US$ 8,316 mm | US$ 3,162 mm | US$ 1,314 mm |
| 9 | Total Impact of Wireless Telephony on Incremental GDP growth | US$ 1,234 mm | US$ 2,434 mm | US$ 2,260 mm | US$ 10 mm |
| 10 | Annualized impact | US$ 176 mm | US$ 347.7 mm | US$ 377 mm | US$ 2.5 mm |

Table 14. Francophone West Africa: Annual Wireless Impact on GDP
Source: TAS analysis
Notes: (*)　Due to Mali's late wireless development, estimates are calculated between 2007 and 2012
　　　　(**) Due to Niger's embryonic wireless penetration, estimates are calculated between 2009 and 2013

In sum, the indirect annual contribution of wireless telephony to the GDP was US$ 176 million for Senegal, US$ 347.72 million for Cote d'Ivoire, US$ 377 million for Mali, and US$ 2.5 million for Niger.

### 5.2.3  Broadband economic impact

The analysis of mobile broadband's impact on the Francophone West Africa economy utilized a model similar to the mobile telephony structural model. The model also consists of four equations: an aggregate production function modeling the operation of the economy and subsequently three demand, supply, and output functions. The latter functions model the mobile broadband market operation and estimate the economic impact of mobile broadband while controlling for the reverse effects. The demand function links mobile broadband penetration to the average consumption propensity of individuals proxied by GDP per capita, the cost of a basic mobile broadband service (price of a monthly subscription), the percent of individuals that fulfill secondary education and the percent of population residing in densely populated urban areas. The supply function links the aggregate mobile broadband revenue to the relevant price levels and the GDP per capita. The infrastructure equation links annual change in mobile broadband penetration to the market revenues, used as a proxy of the capital invested in a country during one year.

The econometric specification of the model is as follows:

Aggregate Production function:
$$GDP_{it} = a_1 K_{it} + a_2 L_{it} + a_3 BB\_Pen_{it} + \varepsilon_{1it} \tag{9}$$

Demand function:
$$BB\_Pen_{it} = b_1 BBPr_{it} + b_2 GDPC_{it} + b_3 Edu_{it} + b_4 Urb_{it} + \varepsilon_{2it} \tag{10}$$

Supply function:
$$BB\_Rev_{it} = c_1 BBPr_{it} + c_2 GDPC_{it} + c_3 HHI_{it} + \varepsilon_{3it} \tag{11}$$

Output function:
$$\Delta BB\_Pen_{it} = d_1 BB\_Rev_{it} + \varepsilon_{4it} \tag{12}$$

However, in this case, the model could not be run for all four countries due to lack of observations. Per the model, mobile broadband appears to have an initial effect on the economy in the case of Senegal. Contrary to the 2010 results that showed no statistically significant results (Katz et al, 2012b), every 1% increase in mobile broadband penetration yields 0.022% growth in GDP (see table 15).

| | **Variables** | **Mobile Broadband Model** |
|---|---|---|
| *Growth (GDP)* | Fixed Capital Stock | 0.632*** |
| | Labor Force | 0.960*** |
| | Mobile Broadband Penetration | 0.022*** |
| | Constant | -21.742*** |
| *Demand (lmbbusers)* | GDPC | -1.565 |
| | Mobile Broadband Price | -6.332*** |
| | Competitive Intensity | -2.719*** |
| | Constant | 36.994** |
| *Supply (lrevenue)* | GDPC | -0.157 |
| | Mobile Broadband Price | 0.246*** |
| | Competitive Intensity | -0.252*** |
| | Constant | 19.885*** |
| *Output (dmb)* | Mobile Broadband Revenue | 11.687 |
| | Constant | -218.389 |
| Controls | Year Effects | YES |
| | Quarter Effects | YES |
| $R^2$ | Growth | 0.99 |
| | Demand | 0.96 |
| | Supply | 0.39 |
| | Output | 0.00 |

Table 15. Senegal: Results of Mobile Broadband Model
Source: TAS analysis

This effect is quite reasonable considering that while the coefficient is lower than what is found in comparable fixed broadband studies, a smaller effect would be expected since mobile broadband is not used as intensively in accessing the Internet as fixed broadband.

In the case of Cote d'Ivoire, the model could not be run due to the limited number of observations. In order to generate statistically significant results for this type of estimation, a minimum of 45 observations are required. Even by collecting quarterly data, the launch of mobile broadband in March 2012 can generate only five observations. That said, mobile broadband has been successfully deployed across the country by at least three operators, which have introduced offers targeted for different market segments.

| Plan type | Orange | MTN | MOOV |
|---|---|---|---|
| Daily, 50 Mb cap | 1,500 (*) | 1,500 (***) | 2,500 (****) |
| Monthly, 5 Gb cap | 10000 | 19,000 | 20,000 |
| Monthly, 10 Gb cap | 15,000 | 39,000 (**) | 39,000 |

Table 16. Cote d'Ivoire: Wireless Broadband Pricing (in FCFA) (3Q2013)
Source: Operators

(*) 350 Mb
(**) 50 Gb
(***) 250 Mb
(****) 350 Mb, weekly

Therefore, given the expected development of mobile broadband in Cote d'Ivoire in the foreseeable future, it is anticipated that this technology will yield an important economic contribution in the years to come (see figure 3).
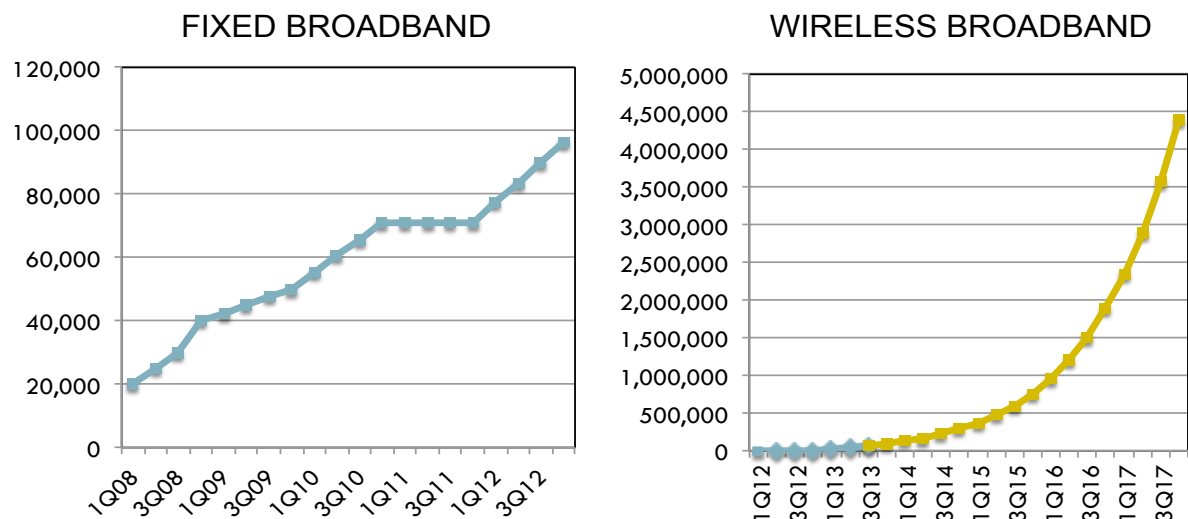


Figure 3: Cote d'Ivoire: Fixed and Wireless Broadband Historical and Forecast
Sources: Informa; GSMA Intelligence

As of the end of 2012, fixed broadband lines in Cote d'Ivoire had reached 96,000, while wireless broadband connections amounted to 10,187. However, by 2017, wireless broadband connections are forecast to reach 4,384,000. Economic effects will be detected by mid-2015, when broadband connections will likely exceed an estimated 600,000.

Likewise, given the recent launch of services in Mali, this model had too few observations and could not be run. In terms of mobile broadband pricing data availability, even after inputting data based on the available three data points (2Q10, 1Q11, and 1Q12), only

twelve observations could be generated, which prevented the authors from running the model presented above. However, given the observed growth in and forecast for the number of mobile broadband connections, we could potentially estimate their economic impact in the near future (see figure 4).
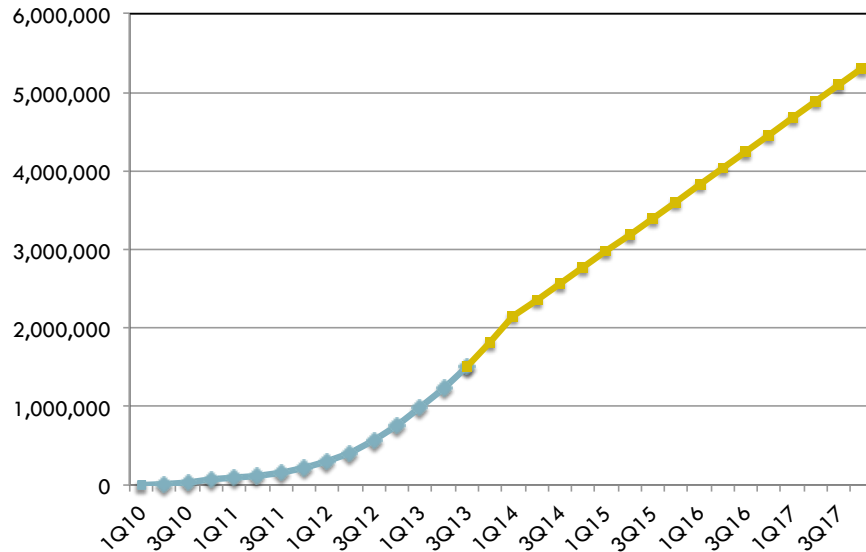


Figure 4: Mali: Wireless Mobile Connections
Source: GSMA Intelligence

The number of mobile broadband connections in Mali reached 1,229,741 as of 2Q2013, almost twice the installed base in other Francophone West Africa countries such as Senegal, where the economic impact of mobile broadband has already been measured. The reduced number of observations is the only barrier to statistically reliable estimates. Along these lines, it is estimated that economic effects, as measured through the model presented above, could be accurately estimated in approximately two years.

A similar conclusion was reached in the case of broadband economic impact in Niger. The future development of mobile broadband in Niger allows to anticipate that this technology will yield an important economic contribution in the years to come (see figure 5).
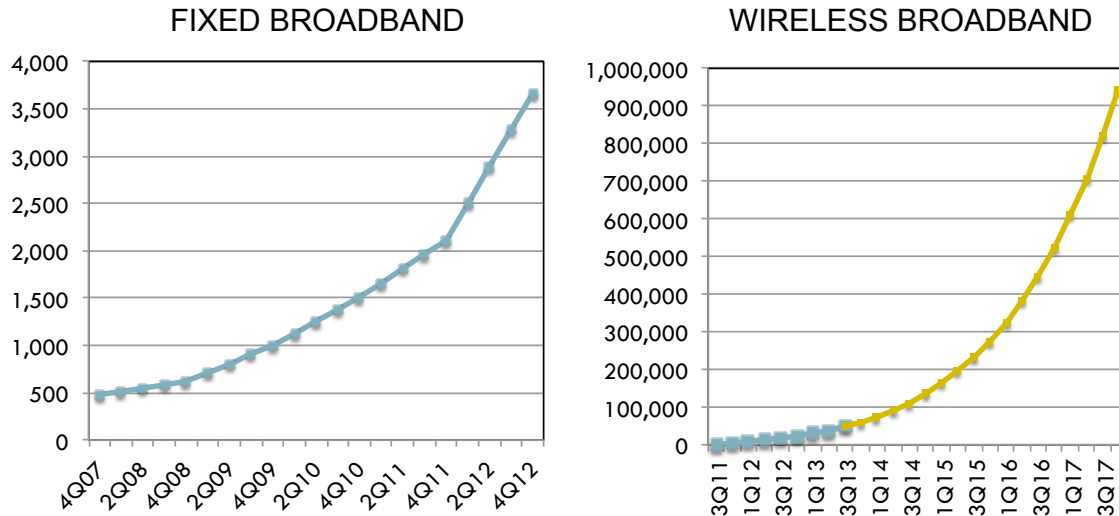
| | FIXED BROADBAND | WIRELESS BROADBAND |
|---|---|---|

Figure 5: Niger: Fixed and Wireless Broadband Hitorical and Forecast
Sources: ITU; GSMA Intelligence

As of the end of 2012, fixed broadband lines in Niger had reached 3,700, while wireless broadband connections amounted to 23,750. However, by 2017, wireless broadband connections are forecast to reach 942,000. It is estimated that by mid-2015, when broadband connections exceed 600,000, economic effects will be detected. A reduction in prices, which will foster adoption, has already been detected. Prices will likely decline further with competitive developments (see table 17).

| | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---|---|---|---|---|---|---|
| Orange | NA | 20 036 | 15 412 | 8 827 | 5 296 | 3 707 |
| Airtel | NA | NA | NA | NA | 5 296 | 3 707 |
| Moov | NA | NA | NA | NA | 4 766 | 3 336 |

Table 17. Niger: Prices of Mobile Broadband Offerings (in Franc CFA)
Source: Operators

Two operators – Moov and Airtel – will launch mobile broadband services in 2014. As a result, Orange will respond with a reduction in its pricing.

In sum, given the very recent deployment of mobile broadband, econometric techniques were not capable of measuring its economic impact in Cote d'Ivoire, Mali or Niger due to either the reduced number of observations (Mali) or limited adoption (Cote d'Ivoire, Niger). Nevertheless, the results for Senegal point to an important contribution, which is expected to extend to the other three countries.

## 6. Policy Implications to facilitate telecommunication adoption and welfare

Ultimately, this study finds that the overarching consensus – that ICT adoption encourages economic growth – holds true for Francophone West Africa, where ICT has impacted the

economy and employment while allowing the country to benefit from many of its positive externalities. In terms of GDP impact, the results are fairly conclusive (see table 18).

| | Senegal | Cote d'Ivoire | Mali | Niger | Total |
|---|---|---|---|---|---|
| National GDP (2012) | US$ 14,160 | US$ 24,680 | US$ 10,308 | US$ 6,568 | US$ 55,716 |
| Direct Telecom. Impact | US$ 1,503 | US$ 1,674 | US$ 557 | US$ 373 | US$ 4,107 |
| Indirect Telecom. Impact | US$ 349 | US$ 348 | US$ 377 | US$ 2 | US$ 1,076 |
| Total Telecom. Impact | US$1,852 | US$ 2,022 | US$ 934 | US$ 375 | US$ 5,183 |
| Percent of National GDP | 13.08 % | 8.19 % | 9.06 % | 5.71 % | 9.30 % |

Table 18. Francophone West Africa: Telecommunications Direct and Indirect Contribution to GDP (in US$ millions unless indicated)
Source: TAS analysis

This study concluded that increased adoption of mobile and broadband technology encourages economic activity by enhancing market access, fostering financial inclusion, delivering training resources, and even developing new sectors. Given the positive relationship between ICT and economic growth, these countries must promote policies that foster adoption while also increasing regulatory stability and promoting local content and services development.

First and foremost, policy makers must create a high level of regulatory certainty in order to stimulate the capital expenditures that will lead to further deployment of 3G networks, which provide the infrastructure to offer mobile broadband services. Second, while market competition has encouraged a decline in prices and increased operator investment in the sector, it is critical to consider that excessive industry fragmentation is detrimental to sustainability and innovation levels. As a result, consumers and the overall sector could experience frictional costs. Third, to stimulate technology adoption, the government should promote the local development of applications, services, and content.

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## APPENDIX A: Data Sources

| Data | Sources |
|---|---|
| Fixed Line subscribers | ITU |
| Mobile subscribers | ITU |
| Mobile unique subscribers | GSMA Intelligence |
| Internet subscribers | ITU |
| Fixed broadband subscriptions | ITU |
| GDP | World Bank |
| Total Wireless Service Revenues | GSMA Intelligence |
| Total Fixed Service Revenues | Pyramid Intelligence |
| HHI | GSMA Intelligence |
| GDP per capita | World Bank |
| Population | GSMA Intelligence |
| Total MTN Connections | GSMA Intelligence |
| MTN Market Share | GSMA Intelligence |
| Total Wireless Connections | GSMA Intelligence |
| Mobile-cellular prepaid – price of a three-minute local call (peak, on-net), in USD | ITU |
| Price of a three-minute local call to a fixed-telephone line (peak rate), in USD | ITU |
| Fixed (wired)-broadband monthly subscription charge, in USD | ITU |
| Gross fixed capital formation (current US$) | World Bank |
| Gross fixed capital formation (constant 2005 US$) | World Bank |
| Gross fixed capital formation (% of GDP) | World Bank |
| Gross capital formation (current US$) | World Bank |
| Gross capital formation (constant 2005 US$) | World Bank |
| Gross capital formation (% of GDP) | World Bank |
| Labor force, total | World Bank |
| School enrollment, tertiary (% gross) | World Bank |
| Total Mobile Connections/Population | GSMA Intelligence |
| 100 - "Rural population (% of total population)" | World Bank |
| Total Mobile Connections Q2 2013 | GSMA Intelligence |
| Internet Service Revenue (US$m) | Pyramid Research |
| Blended ARPU Total | GSMA Intelligence |
| Blended ARPU Total | WCIS |
| ARPU Postpaid | WCIS |
| ARPU Prepaid | WCIS |
| ARPU, by subscriber | GSMA Intelligence |
| Operator ARPU Per Month Postpaid in USD | INFORMA |
| Operator ARPU Per Month Postpaid in USD | INFORMA |
| Operator ARPU Per Month Prepaid in USD | INFORMA |
| Operator ARPU Per Month Prepaid in USD | INFORMA |
| Operator ARPU Per Month Blended in USD | INFORMA |
| Operator ARPU Per Month Blended in USD | INFORMA |
| Operator Total Revenue less Mobile Revenue | INFORMA |
| Operator Total Revenue less Mobile Revenue | INFORMA |
| Operator Total Revenue less Mobile Revenue | INFORMA |
| Operator CAPEX in Millions USD | INFORMA |
| Operator CAPEX in Millions USD | INFORMA |
| Operator CAPEX in Millions USD | INFORMA |
| Operator CAPEX in Millions USD | INFORMA |
| Operator CAPEX in Millions USD | INFORMA |
| Revenue Total | GSMA Intelligence |
| CAPEX Total | GSMA Intelligence |
| DSL Internet subscriptions | ITU |

| | |
|---|---|
| Percentage of the population covered by a mobile-cellular network | ITU |
| Network coverage, by population | GSMA Intelligence |
| Active mobile-broadband subscriptions | ITU |
| Mobile Broadband | GSMA Intelligence |
| Mobile broadband at least 1 GB of CAP (US$) | Google Data |
| Mobile Broadband "MTN" | GSMA Intelligence |

## APPENDIX B: Simple Regression of Niger Mobile Telephony Economic Impact

```
. reg  lgdp  lfcapital  llabedu  lmobpen y_1-y_11 op_1-op_4 qt_1-qt_4
note: y_1 omitted because of collinearity
note: op_4 omitted because of collinearity
note: qt_3 omitted because of collinearity
```

| Source | SS | df | MS | | Number of obs = | 138 |
|---|---|---|---|---|---|---|
| | | | | | F( 19,   118) = | 813.47 |
| Model | 10.7052588 | 19 | .563434672 | | Prob > F      = | 0.0000 |
| Residual | .081729987 | 118 | .000692627 | | R-squared    = | 0.9924 |
| | | | | | Adj R-squared = | 0.9912 |
| Total | 10.7869887 | 137 | .078737144 | | Root MSE     = | .02632 |

| lgdp | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] | |
|---|---|---|---|---|---|---|
| lfcapital | .3274061 | .0516393 | 6.34 | 0.000 | .2251462 | .4296659 |
| llabedu | -.7919483 | .5061219 | -1.56 | 0.120 | -1.794208 | .2103108 |
| lmobpen | .0267323 | .0531315 | 0.50 | 0.616 | -.0784826 | .1319471 |
| y_1 | (omitted) | | | | | |
| y_2 | .0758016 | .0397565 | 1.91 | 0.059 | -.0029271 | .1545303 |
| y_3 | .1499083 | .0722532 | 2.07 | 0.040 | .0068273 | .2929893 |
| y_4 | .1859559 | .0970649 | 1.92 | 0.058 | -.0062591 | .3781709 |
| y_5 | .2779696 | .1216994 | 2.28 | 0.024 | .0369717 | .5189674 |
| y_6 | .4424051 | .148133 | 2.99 | 0.003 | .1490615 | .7357487 |
| y_7 | .5373089 | .1689551 | 3.18 | 0.002 | .2027317 | .8718861 |
| y_8 | .4625666 | .186003 | 2.49 | 0.014 | .0942301 | .8309032 |
| y_9 | .5627932 | .2022524 | 2.78 | 0.006 | .1622783 | .963308 |
| y_10 | .6848334 | .2140624 | 3.20 | 0.002 | .2609316 | 1.108735 |
| y_11 | .73337 | .2215664 | 3.31 | 0.001 | .2946082 | 1.172132 |
| op_1 | -.0006432 | .007449 | -0.09 | 0.931 | -.0153943 | .0141079 |
| op_2 | -.0006432 | .007449 | -0.09 | 0.931 | -.0153943 | .0141079 |
| op_3 | -.0006432 | .007449 | -0.09 | 0.931 | -.0153943 | .0141079 |
| op_4 | (omitted) | | | | | |
| qt_1 | .006018 | .0128135 | 0.47 | 0.639 | -.0193562 | .0313923 |
| qt_2 | .0028639 | .0085943 | 0.33 | 0.740 | -.0141551 | .0198829 |
| qt_3 | (omitted) | | | | | |
| qt_4 | .08819 | .0156704 | 5.63 | 0.000 | .0571583 | .1192217 |
| _cons | 19.13442 | 7.754633 | 2.47 | 0.015 | 3.778139 | 34.49071 |