ASSESSMENT OF THE ECONOMIC IMPACT OF TELECOMMUNICATIONS IN MALI

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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 the economy of Mali.

Following the rapid adoption of mobile telephony, Mali boasts a wireless penetration rate of 89.55%, well above the West Africa average of 71.17%. In addition to the growth in the mobile sector and the takeoff of 3G services, the number of fixed lines nearly doubled over the last 8 years. While this growth is not nearly as dramatic as that of the mobile sector, it shows a muted fixed-mobile substitution effect in comparison to many other emerging countries. On the other hand, the number of fixed broadband subscriptions remains nearly non-existent (2,168 lines in total by the end of 2012), while the mobile broadband market has soared, with the number of mobile broadband subscriptions totaling 763,000 by year end. Increased competition in the mobile market coupled with the launch of the ACE submarine cable will likely result in more affordable and accessible broadband services in Mali.

The telecommunications sector has directly impacted the Malian economy, contributing US\$ 557 million, or 5.2% of the country's GDP, while creating 1,133 direct jobs (i.e. employment within the telecom sector) and an estimated 20,772 indirect jobs. Increased mobile telephony adoption has also generated many positive externalities. The econometric models developed for this study found that every 1% increase in mobile penetration contributed 0.063% to GDP growth. Ultimately, mobile telephony contributed an annual US\$ 377 million to the Malian GDP.

Telecommunications' annual contribution to the Malian GDP in 2012 amounted to, at the very least, US\$ 934 million (of a 2012 GDP of US\$ 6,568 million, which represents 14.2%).

Annual contribution to GDP	Amount
Direct effects of telecommunications	US\$ 557 million
Indirect effects of mobile telephony	US\$ 377 million
Indirect effects of broadband	To be determined
Total	US\$ 934 million

 Table 1. Cumulative Economic effects of telecommunications

 Source: Telecom Advisory Services analysis

While the economic impact of broadband was not estimated due to its limited deployment, it is believed that the country's economy will further benefit from future adoption.

Given the observed direct and indirect benefits of the introduction of mobile phone services, the Malian society would benefit from policies that continue to foster ICT adoption. Further support of a competitive market would likely encourage the decline of prices and increased operator investment in the sector. With the exploding mobile broadband sector, the country needs stability and predictability in its regulatory framework to stimulate the capital expenditures necessary to encourage additional network deployments to accommodate future traffic growth. Lastly, to spur additional demand, policies 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 study 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 improved 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, 2012), Colombia (Katz et al., 2011c), and Philippines (Katz et al., 2012).

The following study analyzes the impact of wireless and broadband communications on the Malian economy. 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.

Now used by the large portion of the Malian population, mobile voice services reflect a mature market that has demonstrably affected the country's economy. This study employs a structural model that depends on four equations modelling the market operation between 2005 and 2013 taking into account:

- Endogenous growth from existing capital and labor together with the ICT infrastructural 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 telecoms market as a proxy for the 'health' and sustainability of the market

During this same time period, the fixed broadband market showed relatively little activity. On the other hand, mobile broadband, which launched in the first quarter of 2010, has grown at a significant pace. In terms of broadband's impact on the economy, this study used a structural model similar to the one used to assess the impact of wireless telephony.

To offer a context for its approach, this study first provides a brief literature review of established research surrounding the economic impact of telecommunications (Section 2). An overview of the Malian economy (Section 3) follows and is complemented by an explanation of the key characteristics of the country's telecommunications market (Section 4). ICT's direct and indirect economic contributions to the economy of Mali are described in Section 5, along with a discussion of the study's methodology and findings. The implications derived from these findings conclude the study (Section 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 permanent, so, too, 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 improves 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); 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

¹ Kelly, Tim, and Michael Minges, eds. *Maximizing Mobile*. Rep. The World Bank, 2012. Web.

<http://siteresources.worldbank.org/EXTINFORMATIONANDCOMMUNICATIONANDTECHNOLOGI ES/Resources/IC4D-2012-Report.pdf>.

² Donner, Jonathan, Shikoh Gitau, and Gary Marsden. "Exploring Mobile-only Internet Use: Results of a

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., 2010a) as well as in Brazil, Chile, India, Saudi Arabia, Indonesia, and the Dominican Republic (Katz, 2011). That said, while all of these countries witnessed a significant employment increase, the growth varied widely. Explanations could include migratory trends (Crandall), 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 the service industries, although some studies also found a presence in the manufacturing sector as well (Crandall et al, 2007). Only the accommodations 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

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.

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>.

et al., 2009a; 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., 2010a). 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, 2012).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, 2012).

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 the economy of Mali.

3. The economy of Mali

A landlocked country in Sub-Saharan Africa amongst the poorest in the world, Mali has made strides in reducing its national-level poverty rate over the past decade, down to 43% in 2010 after reaching 56% in 2001.⁶ 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 supply⁷. Despite economic difficulties and declines in investment, the country has exhibited improvements in fiscal freedom and government spending (down to 23.2% of GDP).⁸

Mali's economy centers on the agriculture, livestock, and fishing sectors, which together employ 70% of the population and produce one-third of national gross domestic product.⁹ Naturally, the agriculture sector depends on rainfall, which subjects the economy to much

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

⁶ World Bank Data http://data.worldbank.org/indicator/SI.POV.NAHC

⁷ http://www.ruralpovertyportal.org/en/country/home/tags/mali

⁸ Heritage Foundation http://www.heritage.org/index/country/mali

⁹ Heritage Foundation http://www.heritage.org/index/country/mali

instability and unpredictability as a result of such events as drought, floods, and erratic rainfall.¹⁰ Crop yields consistently fall well below their potential, although both grain and seed cotton production could increase by 15% in 2013, assuming the government intervenes and finances the purchase of seeds and subsidies for fertilizer and infrastructure.¹¹

While the country does have natural mineral resources, it largely underexploits them and lacks adequate infrastructure to use them to its advantage.¹² Despite its development, the mining sector has not yet generated national enterprises.¹³ The economy has little diversification, with private-sector activity largely occurring outside of the formal sector.¹⁴

Even during the global recession, Mali continued to experience moderate GDP growth of approximately 5% between 2008 and 2010.

	2010	2011	2012	2013	2014	2015
Annual % Change GDP at Market Prices (\$2005)	5.8	2.7	-1.2	4.8	5.9	6.0
Current Account Balance / GDP (%)	-12.6	-6.2	-4.4	-5.4	-7.6	-8.7

Table 2: Mali: Economic Growth

Source: World Bank Global Economic Prospects (June 2013)

In 2011, however, growth fell 50% to 2.73%, with a decline to -1.19% in 2012.¹⁵ 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.¹⁶ 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.

¹⁰ Rural Poverty Portal http://www.ruralpovertyportal.org/country/home/tags/mali

¹¹ http://www.afriquejet.com/news/8405-grain-production-in-mali.html

 ¹² Heritage Foundation http://www.heritage.org/index/country/mali
 ¹³ African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/mali/

¹⁴ Heritage Foundation http://www.heritage.org/index/country/mali

¹⁵ World Bank Data http://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG

¹⁶ African Economic Outlook http://www.africaneconomicoutlook.org/en/countries/west-africa/mali/



Figure 1. Mali: Economic Growth Source: African Economic Outlook; IMF's Regional Economic Outlook

Mali has experienced a consistent 3% population growth rate for the past decade¹⁷ and nearly half (45%) of the population is under 15 years of age, with over 250,000 young people entering the job market each year. The country cannot capitalize on this resource, however, as a result of its inadequate school system and lack of training programs.¹⁸

More than three-quarters (78%) of the Mali population lives in rural areas, which exhibit a poverty rate 53% higher than the national average.¹⁹ Farmers comprise the majority of the rural population, which has limited access to land. Despite the global recession, per capita GDP, while low, has gradually increased over recent years, up to US\$ 694 in 2012 from US\$ 665 in 2008. Inflation has fluctuated somewhat, reaching 9.17% in 2008, declining to 1.11% in 2010, and rising to 5.43% in 2012. Inflation is under control²⁰ and expected to remain moderate as a result of the state's fiscal policy and low domestic borrowing.²¹

¹⁷ World Bank Data http://data.worldbank.org/indicator/SP.POP.GROW

¹⁸ Rural Poverty Portal http://www.ruralpovertyportal.org/country/home/tags/mali

¹⁹ Rural Poverty Portal http://www.ruralpovertyportal.org/en/country/home/tags/mali

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

²¹ IMF DSA 2013 http://www.imf.org/external/pubs/ft/dsa/pdf/2013/dsacr1344.pdf



Source: World Bank (2013)

The IMF noted that Mali's risk of debt distress remains moderate and unchanged since its evaluation in 2011. The risk lies in the country's sensitivity to a "hardening of financial terms or an export shock stemming from the concentration of exports on gold."²² If agricultural and mineral exports increase and overall imports decrease, GDP growth will likely continue despite the decline in gold production. As a percent of GDP, national imports have decreased from 43.00% in 2008 to 36.24% in 2011 while exports have also decreased over this same time period from 29.20% to 25.53%. The balance of goods and services has fluctuated somewhat, declining from -13.80% in 2008 to -7.62% in 2009 and reaching -10.71% in 2011.²³

The country has not fully institutionalized free trade and foreign investment and an 8.4% average trade-weighted tariff plus other trade restrictions stand between Mali and the global economy. ²⁴ Foreign Direct Investment has remained low but stable - approximately 1.2% of GDP in 2008 and 1.67% in 2011 - although this number noticeably declined to .29% in 2010. Investment lags as a result of instability and government corruption. On a similar note, banks cannot offer adequate financing, forcing much of the population to rely on informal lending.²⁵

Mali's gross fixed capital formation has increased slightly, up to 22.16% in 2011 from 18.29% in 2008. Its public debt equals approximately one-third of GDP.²⁶ External debt has declined significantly in the past decade as a result of the HIPC Initiative and the MDRI, falling from 103% of GDP in 2000 to 19% in 2006, although it had increased to 28% of GDP at year-end 2011. This increase comes as a result of multiple loans, largely from multilateral creditors. At 4.7% of GDP, domestic debt is relatively small, although it

²² IMF DSA 2013 http://www.imf.org/external/pubs/ft/dsa/pdf/2013/dsacr1344.pdf

²³ World Bank Data http://data.worldbank.org/indicator/NE.RSB.GNFS.ZS

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

²⁵ Heritage Foundation http://www.heritage.org/index/country/mali

²⁶ Heritage Foundation http://www.heritage.org/index/country/mali

has more than doubled since 2009 as a result of new issuances of treasury bonds as well as an updated assessment of all outstanding loans.²⁷



Figure 3. Mali: Foreign Trade and Gross Capital Formation Source: World Bank (2013)

In the context of Mali's economy, telecommunications infrastructure should play a fundamental role. In the first place, telecommunications can improve productivity of small farmers, by enhancing their access to inputs while facilitating market reach. Secondly, telecommunications could represent the underlying network that would foster financial inclusion of a population largely marginalized from banking services. Thirdly, broadband could facilitate the delivery of training resources, thereby supplementing a strained educational system. And, finally, telecommunications could support, albeit tangentially, the development of a national mining sector.

4. The Telecommunications Industry in Mali

4.1.Telecommunications demand

Over the past eight years, 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. This adoption has fuelled rapid growth of the country's telecommunications sector (see Figure 4).

²⁷ IMF DSA 2013



ure 4: Mobile, Fixed-line, Broadband, and 3G subscribers in Ma Sources: ITU and Wireless Intelligence

In terms of mobile penetration, when compared to other West African countries, Mali ranks fifth of the fifteen countries. Its 89.55% mobile penetration rate is well above the regional average of 71.17%, and it falls behind only Benin (89.91%), Cote d'Ivoire (96.27%), Ghana (100.28%), and Mauritania (111.06%).



Figure 5: Mali belongs to the middle cluster for mobile penetration in West Africa Source: ITU (2011)



Interestingly, even with the dramatic increase in wireless subscriptions, the number of fixed access lines 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%. The simultaneous growth of both technologies indicates that the market will utilize any available technology that meets its needs. While the growth rate is dramatically higher for mobile than for fixed telephony, the Malian market does not exhibit as great a technology substitution dynamic as what other emerging countries have experienced.²⁸

With under 2,200 subscriptions, fixed broadband penetration continues to hover at 0.01% penetration. While fixed broadband has not yet taken off, 3G subscriptions have skyrocketed. Prior to May 2010, the service was not offered in the country. By year end 2010, Mali had 67,000 3G subscriptions. One year later, this number had grown to 217,000 and by Q4 2012, Mali recorded 763,000 3G subscriptions, or 10% of the mobile market.

With the introduction of the third mobile provider and the launch of the Africa Coast to Europe (ACE) submarine cable, broadband services could soon become more affordable and accessible, driving broadband penetration rates. Further, the launch of services like Orange's mobile money will likely spur broadband demand.

4.2. Telecommunications supply

²⁸ See the example of Latin American countries

Incumbent Sotelma controlled the mobile market until Ikatel - now Orange Mali launched services in 2003 after the Malian government offered a fixed-line, mobile, and Internet services license. Orange Mali is a subsidiary of Orange and 70.05% owned by Sonatel SA. 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), beating out Viettel and Bharti. In September 2013, however, it was announced that the operator could lose the license due to non-payment. The new licensee made an initial US\$ 67.8 million payment in February 2013, but did not make the \$50 million payment that was due in February.²⁹

At present (2013), Orange Mali leads the mobile market with 10.4 million customers and a 57 % market share 30

	2009	2010	2011	2012	2013
Sotelma	19.05 %	31.43 %	40.44 %	41.24 %	42.45 %
Orange	80.95 %	68.57 %	59.56 %	58.76 %	57.55 %

Table 3: Subscriber market shares in the Malian mobile market Source: GSMA Intelligence

Orange's launch of low-priced handsets, collect call services, and discounted services during non-peak times has expanded its reach³¹ to previously underserved segments of the population. Further, the operator brought "community phones" to a number of villages in the country.

Over the course of the past 15 years, total service revenues have multiplied nearly tenfold from US\$ 56.34 million in 1996 to US\$ 557.40 million in 2011 (see Figure 10). 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 industry saw its highest revenues to date, US\$563.32 million. For the first time since 2000, Mali's telecommunications sector 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. ^{32 33}As 3G services gain momentum, a further increase in revenue could likely follow.

²⁹ Source: TeleGeography

³⁰ Orange http://www.orange.com/en/group/global-footprint/countries/Group-s-activities-in-Mali

³¹ Orange Mali's broadband Internet network covered approximately 80% of the population and 38% of the country in 2012.

³² Source: Reuters, Maroc Telecom

http://www.reuters.com/article/2013/07/24/idUSnHUGdczh+70+ONE20130724 ³³ Source: TeleGeography



From 2001 - 2004, revenue growth within the Malian telecom market well surpassed that of the country's change in real GDP (see Figure 11). At its height in 2004, when telecommunications revenue grew 55.85%, real GDP only grew 2.19%. 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%.



Figure 8: Annual change in real GDP and Telecom Market 1996-2011 Sources: ITU (2013); World Bank

While the increase in mobile phone penetration has largely contributed to sector revenue growth, the decline in mobile ARPU (Average Revenue per User) resulted in the stabilization and drop in sector revenue (See Figures 9 and 10).



Figure 9: Evolution of ARPU (Left Orange Mali Prepaid ARPU; Right: Orange Mali Blended ARPU) Source: INFORMA



Figure 10: Evolution of ARPU (SOTELMA ARPU Blended) Source: INFORMA

5. The economic impact of telecommunications in Mali

The impact of telecommunications on the Malian economy needs to be assessed first in terms of the sector's direct impact, as measured by its contribution to the GDP as well as the employment opportunities generated by its operators and their local suppliers. On the other hand, as a general purpose technology, telecommunications also has an indirect impact on the economy that results from the positive externalities reviewed in chapter 2. This chapter will assess the direct and indirect contributions that telecommunications has made to economic development in Mali.

5.1. Direct economic contribution

The total revenues of Mali's telecommunications industry in 2012 totalled US\$ 557 million, or 5.2% of the country's GDP.



Beyond its contribution to overall GDP, the value-added of the telecommunications sector is estimated at US332 million in 2012^{34} .

In addition to its direct monetary contribution to the economy, the industry also fuelled job creation. In 2011, the telecommunications sector accounted for 1,133 direct jobs³⁵ (i.e. employment within the telecom sector) and an estimated 20,772 indirect jobs. Combined, these jobs equated to 0.29% of Mali's total employment.

5.2. Indirect economic contribution

As shown in the literature reviewed above, beyond the direct economic contribution, telecommunications can also contribute indirectly. This section assesses the positive externalities of telecommunications for Mali. As anticipated in the introduction, given the different penetration rates exhibited by mobile telephony and broadband, the analysis of economic impact of both technologies will be conducted through two different econometric models.

5.2.1 Data Availability

Regional and country-level statistical studies of ICT's impact in emerging economies tend to suffer from lack of microdata as institutions and technical committees do not

³⁴ Calculated by the ratio of Transportation and Communications to GDP, as provided by the African Central Bank.

³⁵ Source: AMRTP

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 for information: GSMA Intelligence, International telecommunications Union, Informa, and Pyramid Research as well as data from the local regulator – Autorité Malienne de Régulation des telecommunications (AMRTP).

In addition, data also came from the operators. The operators provide telecommunications' costs and, in the case of mobiles, are disagregated in pre- and post-paid ARPUs. Other macroeconmic metrics (GDP, fixed capital formation, education, labor force, etc.) are available from the World Bank and IMF. Local operators also make available market performance metrics (capex, revenues, etc.). Data sources are included in Appendix A.

5.2.2 Mobile telephony economic impact

To measure the indirect economic impact of mobile telephony on the 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 infrastructures 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:

$$GDP_{it} = a_1 K_{it} + a_2 L_{it} + a_3 Mob_P en_{it} + \varepsilon_{1it}$$
(1)

Demand function:

$$Mob_Pen_{it} = b_1 MobPr_{it} + b_2 GDPC_{it} + b_3 HHI_{it} + \varepsilon_{2it}$$
 (2)

Supply function:

$$Mob_Rev_{it}=c_1MobPr_{it}+c_2GDPC_{it}+c_3HHI_{it}+\varepsilon_{3it}$$
(3)

$$\frac{Output \text{ function:}}{\Delta Mob_Pen_{it}} = d_1 Mob_Rev_{it} + \varepsilon_{4it}$$
(4)

These models estimated that mobile telephony has significantly affected the Malian

economy during the last 7 years (2005-2012). The annualized average contribution to the Gross Domestic Product is equal to an estimated 0.063% of GDP growth for every 1% increase of mobile penetration (see Table 7).

Variables	Mobile Model
Growth (GDP _{it})	
Labour force (L _{it})	0.331***
Fixed Capital Stock (K _{it})	0.333***
Mob Penetration (Mob_Pen _{it})	0.063**
Constant	-
Demand (Mob_Pen _{it})	
GDPC (GDPC _{it})	4.777***
Mob. Price (MobPr _{it})	0.039
Market Concentration (HHI _{it})	-0.001***
Constant	-12.574***
Supply (Mob_Rev _{it})	
Mob Price (MobPr _{it})	1.002***
GDPC (GDPC _{it})	4.822***
Market Concentration (HHI _{it})	-0.001***
Constant	-12.010***
Output (<i>AMob_Pen_{it}</i>)	
Mob Revenue (Mob_Rev _{it})	1.659***
Constant	-35.252***
Year Effects	YES
Quarter Effects	YES
Operator Effects	YES
\mathbb{R}^2	
Growth	0.99
Demand	0.96
Supply	0.88
Output	0.54

Table 4. Results of Mobile Telephony ModelSource: Telecom Advisory Services analysis

The model results confirm the economic spillover of wireless telephony in Mali. In addition, the structural model yields other interesting findings:

- Incomes are crucial for adoption (coefficient: 4.777) and investments (coefficient: 4.822)
- Competition has a positive impact on investments (coefficient: -.0001) and on adoption (coefficient: -.0001)

The actual contribution of mobile technology was calculated by multiplying the compound annual growth rate of wireless penetration between 2007^{36} and 2013 (Formula 5) by the coefficient of economic impact derived from the econometric model presented in Table 4 (Formula 6):

CAGR = (Wireless penetration 1Q2013 (94.78%)-Wireless penetration 1Q2007 (12.38%)) $^{(1/6)-1}$ (5)

The CAGR for wireless telephony in Mali for the period 2007-2013 is 40.39%.

Impact of wireless on GDP (2008-2013)= CAGR (40.39%)*Coefficient of Impact (0.063) (6)

According to the formula, mobile phones' contribute 2.54% of GDP annually. Based on the difference between 2012 GDP of US\$ 10,308 million and 2007 GDP of US\$ 7,145 million, the indirect annual contribution of wireless telephony to the GDP of Mali amounts to \$ 377 million (see calculations in Appendix B).

Furthermore, looking at the results in light of the Gruber and Koutroumpis' model (2011), with a median mobile penetration of approximately 34.40% in the sample period, Mali had a coefficient of 0.063, indicating an acceleration of impact (see Figure 12).



Figure 12: Wireless Telephony Impact: Country Model Results Versus Global Sample Estimates Note: Estimate based on fitted line of previous studies (median mobile penetration: 34.40 %) Source: Telecom Advisory Services analysis

The vast heterogeneity experienced in Gruber and Koutroumpis' exponential model could partially explain why this new coefficient is higher than their estimate. The curve represents the "average case" and each country can perform differently depending on its

³⁶ The starting point of the time series was moved to 2007 from 2005 to avoid overestimating economic impact as a result of including a period of exponential growth.

individual macroeconomic and institutional conditions. However, another potential explanation - about which we remain cautious - is that the economic contribution of mobile telephony is accelerating due to the launch of new services that rely on telecommunications to reach consumers. We consider, in particular, financial services like mobile money that rely on text messaging.

5.2.3 Broadband economic impact

To analyze mobile broadband's impact on the Malian economy, we 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:

$$GDP_{it} = a_1 K_{it} + a_2 L_{it} + a_3 BB_P en_{it} + \varepsilon_{1it}$$
(6)

$$\frac{Demand function:}{BB_Pen_{it}} = b_1 BBPr_{it} + b_2 GDPC_{it} + b_3 Edu_{it} + b_4 Urb_{it} + \varepsilon_{2it}$$
(7)

$$Supply function:$$

$$BB_Rev_{it} = c_1 BBPr_{it} + c_2 GDPC_{it} + c_3 HHI_{it} + \varepsilon_{3it}$$
(8)

$$\frac{\text{Output function:}}{\Delta BB_Pen_{it}} = d_1 BB_Rev_{it} + \varepsilon_{4it}$$
(9)

However, given the recent launch of services, the 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.



Source: GSMA Intelligence

The number of mobile broadband connections 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.

6. Policy Implications to facilitate telecommunication adoption and welfare

Telecommunications' annual contribution to the Malian GDP in 2012 amounted to, at least, US\$ 934 million (of a 2012 GDP of US\$ 6,568 million, which represents 14.2%).

Annual contribution to GDP	Amount
Direct effects of telecommunications	US\$ 557 million
Indirect effects of mobile telephony	US\$ 377 million
Indirect effects of broadband	To be determined
Total	US\$ 934 million

Table 1. Cumulative Economic effects of telecommunicationsSource: Telecom Advisory Services analysis

While the limited deployment of broadband prevented the authors from estimating its economic impact, we believe that increased adoption will yield future benefits.

Given the observed direct and indirect benefits of the introduction of mobile phone services, the Malian society would benefit from policies that continue to foster ICT adoption. Further support of a competitive market will likely encourage the decline of prices and increased operator investment in the sector.

With the exploding mobile broadband sector, the country needs stability and predictability in its regulatory framework to stimulate the capital expenditures necessary to encourage additional network deployments to accommodate future traffic growth. Lastly, to spur additional demand, policies should promote the local development of applications, services, and content.

7. Conclusion

In sum, this study finds that the overarching consensus – that telecommunications adoption encourages economic growth – holds true for Mali, where it has impacted the economy and employment while allowing the country to benefit from many of its positive externalities. This study concluded that not only did the telecommunications sector account for more than 5% of Mali's GDP, but also that every 1% increase in mobile penetration generated an additional 0.063% of GDP. Increased adoption of mobile and broadband technology can further encourage 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, Mali must encourage policies that foster adoption while also increasing regulatory stability and promoting local content and services development.

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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: Calculation of Wireless Telephony Indirect Contribution to GDP Impact in Mali

Item	Component	Value	Source or Formula
1	Annual contribution of wireless telephony to GDP growth (for every 10% increase in wireless penetration)	0.63	Coefficient of model in table 7
2	Wireless telephony penetration 1Q2013	94.78 %	GSMA Intelligence
3	Wireless telephony penetration 1Q2007	12.38 %	GSMA Intelligence
4	CAGR Wireless telephony penetration	40.39 %	(Wireless telephony penetration 2Q2013/ Wireless telephony penetration 4Q2007)^(1/6 years)-1
5	Annual impact of wireless on GDP	2.54 %	(Annual contribution/10) * CAGR Wireless telephony penetration
6	CAGR GDP per capita (2007-2012)	3.56 %	(GDP PC 2012/ GDP PC 2007)^(1/5years)-1
7	Percent contribution of wireless telephony to GDP growth	71.47 %	Annual impact of wireless on GDP / CAGR GDP per capita (2007-2012)
8	Incremental GDP (2012-2007)	US\$ 3,162 mm	GDP 2012 – GDP 2007
9	Total Impact of Wireless Telephony on Incremental GDP growth	US\$ 2,260 mm	Incremental GDP (2012-2007) * Percent contribution of wireless telephony to GDP growth
10	Annualized impact	US\$ 377 mm	Total impact/6