

ASSESSMENT OF THE ECONOMIC IMPACT OF TELECOMMUNICATIONS IN SENEGAL (2003-2014)

April 2016

Telecom Advisory Services, LLC

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The following study was funded by the General Secretariat of Orange. The views expressed in the report are those of the authors and do not necessarily reflect the opinions of Orange.

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1. BACKGROUND:

The authors have run structural models to measure the indirect economic impact of telecommunications in Senegal over three periods:

Table 1. Senegal: Econometric analyses of indirect economic impact on GDP

	Wireless Telecommunications	Fixed Broadband	Wireless Broadband
First period ¹	2003-2010	2004-2010	2009-2010
Second period ²	2004-2011	2004-2011	2009-2012
Third period ³	2003-2014	2004-2014	2009-2014

The results for the **first two periods** presented in prior papers can be synthesized as follows:

- Wireless telecommunications: the indirect economic impact of wireless telecommunications increases with penetration
- Fixed broadband: fixed broadband did not have statistically significant indirect effects in either the first period (5.30% household and 0.63% individual penetration) or the second period (6.08% household and 0.73% individual penetration)
- Wireless broadband: at penetration levels of 0.29% (first period), wireless broadband did not have indirect economic effects; however, at 3.42% penetration (second period), wireless broadband appeared to show some economic effect

These results are supported by the coefficient of impact of penetration over GDP growth (see table 2).

Table 2. Impact on GDP growth every 1% increase in technology penetration

	Wireless telecommunications	Fixed broadband	Wireless Broadband
First period	0.044%	No impact	No impact
Second period	0.061%	No impact	0.022%

Source: TAS analysis

The results of the first two waves appear to confirm the “return to scale” effect, which stipulates that an increase in technology penetration yields higher economic contribution. At the same time, results would indicate that below an adoption threshold, telecommunications does not have a verifiable aggregate economic

¹ **2012** : *The economic impact of telecommunications in Senegal* (*) By Dr. Raul Katz and Dr. Pantelis Koutroumpis. Final version 06/06/2012.

² **2014** : *Assessment of the economic impact of telecommunications in Senegal* (2010-2013), December 2013. V11 Final version 02/02/2014

³ Current report

contribution. The results of the second wave would provide support for a hypothesis that would indicate that higher penetration levels in the third period would yield more important economic effects.

2. WIRELESS TELECOMMUNICATIONS EFFECT IN THE THIRD PERIOD STUDIED (2003-2014)

The model run for wireless telecommunications with an extended time series (138 observations) indicates that every increase of 1% in wireless telecommunications yields 0.091% growth in GDP (see table 3).

Table 3. Senegal: Indirect Economic impact of mobile telecommunications (2003-2014)

Three-stage least-squares regression

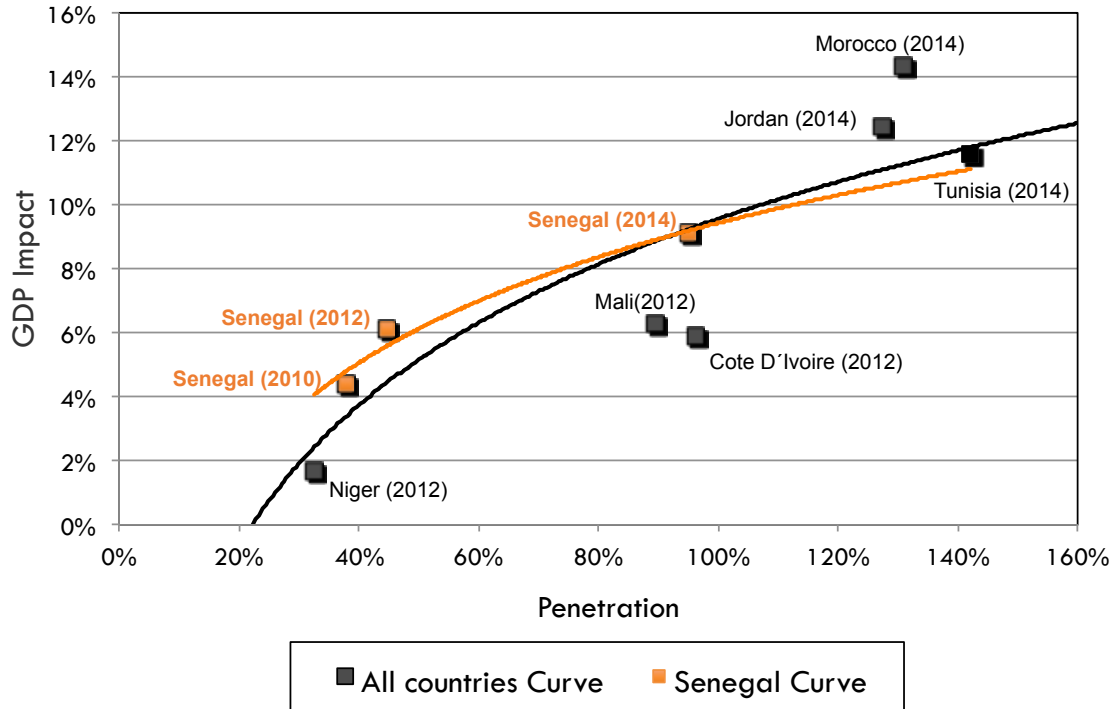
Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	138	17	.0166812	0.9958	3.71e+07	0.0000
lmobusers	138	5	.0907299	0.9883	13137.57	0.0000
lrevenuemo-e	138	3	.1281306	0.9513	2765.54	0.0000
mobgrowth	138	1	.0153774	0.1294	28.34	0.0000

	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lgdp1						
lfcapital_3	.528203	.037667	14.02	0.000	.454377	.602029
llabedu_1	.160019	.0625084	2.56	0.010	.0375048	.2825332
lmobusers	.0907353	.0309176	2.93	0.003	.0301378	.1513327
yr_6	.0120036	.012127	0.99	0.322	-.0117648	.035772
yr_7	-.0378066	.0222274	-1.70	0.089	-.0813716	.0057583
yr_8	-.0505462	.0300347	-1.68	0.092	-.1094132	.0083208
yr_9	-.0298708	.03662	-0.82	0.415	-.1016448	.0419031
yr_10	-.0037454	.0448297	-0.08	0.933	-.0916099	.0841192
yr_11	.0285992	.0502183	0.57	0.569	-.0698269	.1270252
yr_12	.0421842	.0535864	0.79	0.431	-.0628432	.1472116
yr_13	.0369593	.0555972	0.66	0.506	-.0720091	.1459277
yr_14	.0111792	.0583554	0.19	0.848	-.1031954	.1255537
yr_15	.0045116	.0596023	0.08	0.940	-.1123068	.1213299
qt_1	1.445333	.3488896	4.14	0.000	.7615222	2.129144
qt_2	1.445361	.3485838	4.15	0.000	.7621496	2.128573
qt_3	1.442291	.3484444	4.14	0.000	.759352	2.125229
qt_4	1.445515	.3483867	4.15	0.000	.76269	2.128341
_cons	(omitted)					
lmobusers						
lnfixed	.7732688	.084249	9.18	0.000	.6081438	.9383938
lnrural	-15.40341	3.111486	-4.95	0.000	-21.50181	-9.30501
lgdpc1	2.892744	.0869423	33.27	0.000	2.72234	3.063148
lmobcost	-.5164575	.0812355	-6.36	0.000	-.6756762	-.3572388
hhi_mobile	.6277183	.1668251	3.76	0.000	.3007471	.9546895
_cons	45.67899	12.25816	3.73	0.000	21.65344	69.70455
lrevenuemo-e						
lgdpc1	3.021578	.0952991	31.71	0.000	2.834795	3.208361
lmobcost	-.4344031	.0734616	-5.91	0.000	-.5783851	-.290421
hhi_mobile	1.275007	.2292653	5.56	0.000	.8256556	1.724359
_cons	-7.583733	1.78873	-4.24	0.000	-11.08958	-4.077887
mobgrowth						
lrevenuemo-e	-.0119807	.0022507	-5.32	0.000	-.0163919	-.0075694
_cons	.2430302	.042031	5.78	0.000	.1606511	.3254094
Endogenous variables: lgdp1 lmobusers lrevenuemo-e mobgrowth						
Exogenous variables: lfcapital_3 llabedu_1 yr_6 yr_7 yr_8 yr_9 yr_10 yr_11 yr_12 yr_13 yr_14 yr_15 qt_1 qt_2 qt_3 qt_4 lnfixed lnrural lgdpc1 lmobcost hhi_mobile						

Source: TAS analysis

The results confirm the hypothesis of increasing returns to a growth in mobile telecommunications penetration (see figure 1).

Figure 1. Mobile Telecommunications Economic Impact vs. Wireless penetration



Source: TAS analysis

As figure 1 indicates, the return to scale in Senegalese mobile telecommunications is fairly consistent with that of all countries for which we have developed structural models.

It should be noted, however, that the increase in the impact coefficient of last year is due, in large part, to the deployment of wireless broadband. For this reason, we have chosen to study the impact of mobile broadband on the Senegalese GDP growth in isolation.

3. MOBILE BROADBAND EFFECT IN THE THIRD PERIOD STUDIED (2009-2014)

The econometric model run with slight adjustment in control variables (inclusion of percent of rural population) confirms again the increasing returns to scale. In this case, each 1% increase in mobile broadband penetration yields 0.040% of GDP growth (see table 4).

Table 4. Senegal: Indirect Economic impact of mobile broadband (2009-2014)

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	69	11	.0083589	0.9804	5032.01	0.0000
lmbusers	69	4	.2750386	0.9822	4668.48	0.0000
lrevenuemb	69	3	.4784539	0.9487	1311.09	0.0000
mbbgrowth	69	1	.1289497	0.1699	15.69	0.0001

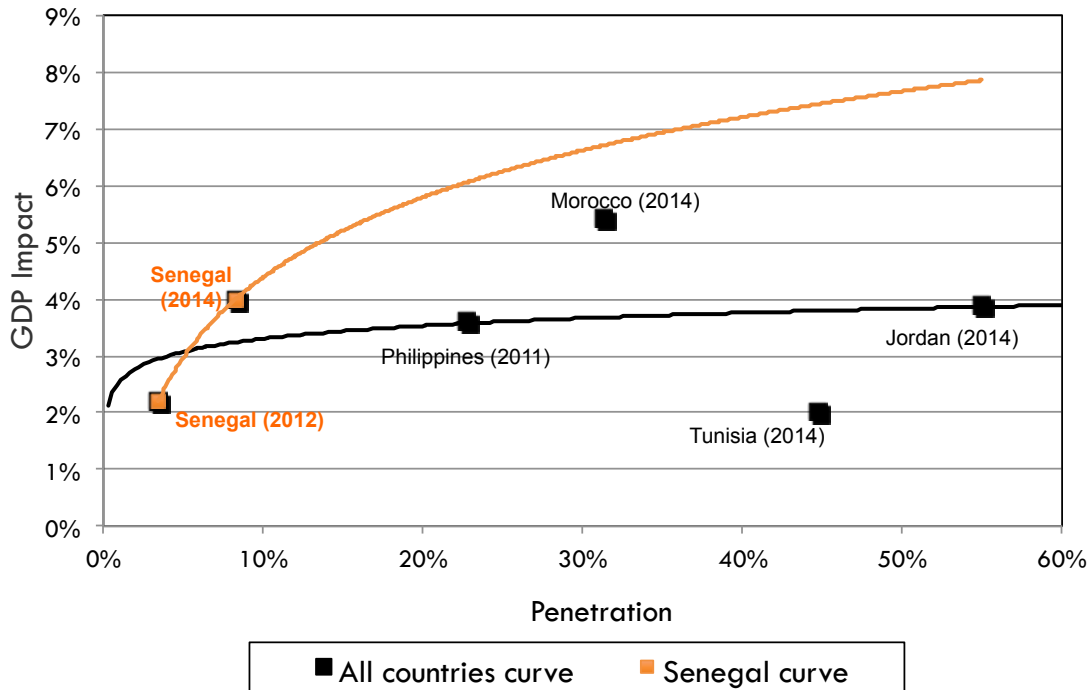
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]
lgdp1					
lfcapita1_3	.5299359	.0350203	15.13	0.000	.4612973 .5985744
llabedu_1	.6752694	.1528408	4.42	0.000	.3757069 .9748318
lmbusers	.0403781	.0050754	7.96	0.000	.0304306 .0503257
yr_11	-.0289084	.0088143	-3.28	0.001	-.046184 -.0116328
yr_12	-.0557105	.0172994	-3.22	0.001	-.0896166 -.0218044
yr_13	-.0937482	.0240393	-3.90	0.000	-.1408643 -.046632
yr_14	-.1364865	.0280709	-4.86	0.000	-.1915043 -.0814686
yr_15	-.161917	.0328703	-4.93	0.000	-.2263417 -.0974924
qt_1	.0088488	.0027048	3.27	0.001	.0035474 .0141501
qt_2	(omitted)				
qt_3	-.0063216	.0024765	-2.55	0.011	-.0111755 -.0014677
qt_4	-.0132226	.0036687	-3.60	0.000	-.0204131 -.0060322
_cons	.8775793	.4776031	1.84	0.066	-.0585055 1.813664
lmbusers					
lnrural	-143.7848	12.15168	-11.83	0.000	-167.6017 -119.968
lgdpc1	.4149635	1.513962	0.27	0.784	-2.552347 3.382274
lmbbcost	-5.340455	2.607021	-2.05	0.041	-10.45012 -.2307872
hhi_fbb	-4.646258	.2927568	-15.87	0.000	-5.220051 -4.072465
_cons	640.864	57.8132	11.09	0.000	527.5522 754.1757
lrevenuemb					
lgdpc1	4.543619	3.010196	1.51	0.131	-1.356257 10.4435
lmbbcost	22.52206	2.819433	7.99	0.000	16.99607 28.04805
hhi_fbb	-7.82296	.279841	-27.96	0.000	-8.371439 -7.274482
_cons	-29.95034	18.21574	-1.64	0.100	-65.65254 5.751848
mbbgrowth					
lrevenuemb	-.0291059	.0073482	-3.96	0.000	-.0435081 -.0147037
_cons	.5454975	.1111932	4.91	0.000	.3275628 .7634323

Endogenous variables: lgdp1 lmbusers lrevenuemb mbbgrowth
Exogenous variables: lfcapita1_3 llabedu_1 yr_11 yr_12 yr_13 yr_14 yr_15
qt_1 qt_2 qt_3 qt_4 ln rural lgdpc1 lmbbcost hhi_fbb

Source: TAS analysis

The results confirm the hypothesis of increasing returns to a growth in mobile broadband penetration (see figure 2).

Figure 2. Mobile Broadband Economic Impact vs. Mobile Broadband penetration



Source: TAS analysis

The results for the structural model of the third period might indicate stronger returns to penetration in Senegal than when all countries are considered, although it might be prudent to rerun the model in two years to determine whether the effects continue being as strong as they might indicate until now.

4. FIXED BROADBAND EFFECT IN THE THIRD PERIOD STUDIED (2004-2014)

The econometric model run with slight control variable adjustment (inclusion of percent of rural population and penetration of fixed telephone) confirms again the increasing returns to scale. In this case, each 1% increase in fixed broadband penetration yields 0.050% of GDP growth (see table 5).

Table 5. Senegal: Indirect Economic impact of fixed broadband (2004-2014)

Three-stage least-squares regression						
Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	132	16	.009706	0.9983	82454.39	0.0000
lfbbusers	132	5	.1064891	0.9853	9842.00	0.0000
lrevenuefbb	132	3	.267111	0.9182	1497.33	0.0000
fbbgrowth	132	1	.0100946	0.8921	1075.53	0.0000

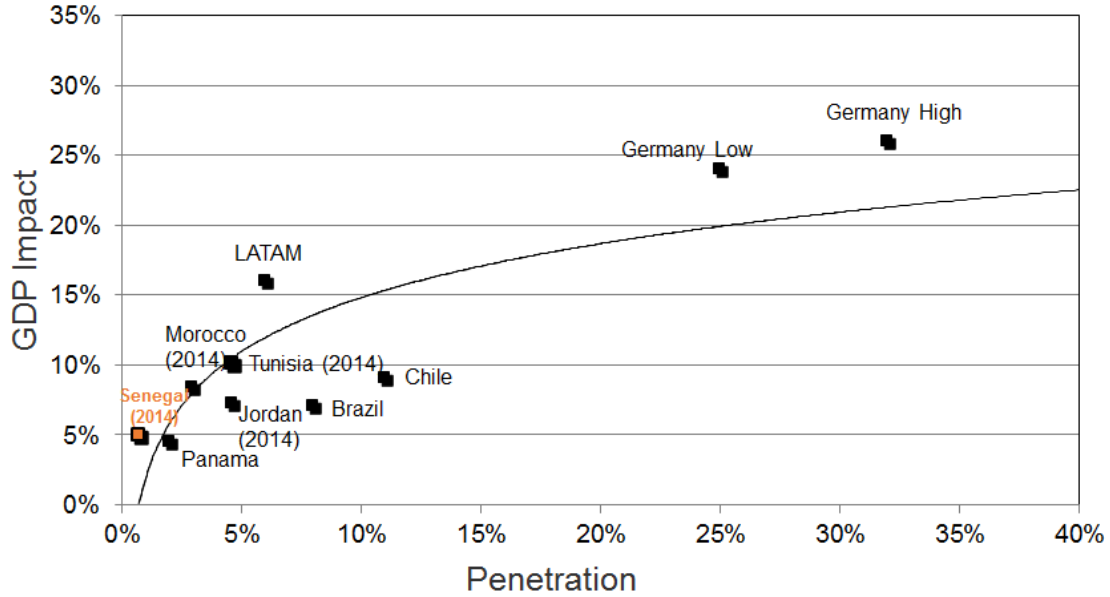
	Coef.	Std. Err.	z	P> z	[95% Conf. Interval]	
lgdp1						
lfcapital_3	.3979862	.029241	13.61	0.000	.3406749	.4552975
llabedu_1	.310456	.043847	7.08	0.000	.2245175	.3963944
lfbbusers	.0496436	.0098722	5.03	0.000	.0302945	.0689928
yr_1	(omitted)					
yr_2	(omitted)					
yr_3	-.1112142	.0284378	-3.91	0.000	-.1669513	-.0554771
yr_4	-.1174404	.0208293	-5.64	0.000	-.1582651	-.0766157
yr_5	-.1523611	.0156868	-9.71	0.000	-.1831067	-.1216154
yr_6	-.1306684	.011849	-11.03	0.000	-.1538921	-.1074447
yr_7	-.0929778	.0076319	-12.18	0.000	-.107936	-.0780196
yr_8	-.0716736	.0074799	-9.58	0.000	-.0863338	-.0570133
yr_9	-.0451375	.0086212	-5.24	0.000	-.0620348	-.0282403
yr_10	-.0107653	.007266	-1.48	0.138	-.0250063	.0034757
yr_11	-.0011762	.0059433	-0.20	0.843	-.0128248	.0104724
yr_12	-.0131672	.0045215	-2.91	0.004	-.0220293	-.0043051
yr_13	(omitted)					
qt_1	-.0103537	.0031393	-3.30	0.001	-.0165067	-.0042007
qt_2	-.0071361	.0026491	-2.69	0.007	-.0123283	-.0019439
qt_3	-.0037817	.002334	-1.62	0.105	-.0083562	.0007928
qt_4	(omitted)					
_cons	2.961857	.2930098	10.11	0.000	2.387569	3.536146
lfbbusers						
lnrural	-53.71026	3.313293	-16.21	0.000	-60.2042	-47.21632
lnfixed	4.531669	.1790677	25.31	0.000	4.180702	4.882635
lgdpc1	4.184995	.1138342	36.76	0.000	3.961884	4.408106
lfbbcost	.1773864	.6024706	0.29	0.768	-1.003434	1.358207
hhi_fbb	1.882217	.1289963	14.59	0.000	1.629389	2.135045
_cons	165.308	12.17667	13.58	0.000	141.4421	189.1738
lrevenuefbb						
lgdpc1	4.8101	.2026184	23.74	0.000	4.412975	5.207225
lfbbcost	-1.283922	1.502834	-0.85	0.393	-4.229421	1.661578
hhi_fbb	-.5391046	.2138387	-2.52	0.012	-.9582207	-.1199884
_cons	-1.293555	4.353758	-0.30	0.766	-9.826765	7.239654
fbbgrowth						
lrevenuefbb	-.0308847	.0009417	-32.80	0.000	-.0327305	-.0290389
_cons	.5018322	.0145104	34.58	0.000	.4733923	.5302722

Endogenous variables: lgdp1 lfbbusers lrevenuefbb fbbgrowth
 Exogenous variables: lfcapital_3 llabedu_1 yr_1 yr_2 yr_3 yr_4 yr_5 yr_6 yr_7 yr_8 yr_9 yr_10 yr_11 yr_12 yr_13 qt_1 qt_2 qt_3 qt_4 lnrural lnfixed lgdpc1 lfbbcost hhi_fbb

Source: TAS analysis

The results do not allow yet to confirm the hypothesis that fixed broadband appears to have an economic contribution once it passes a threshold in penetration since penetration in 2014 is still fairly low: stabilized at 0.71% individual. However, the reason why an economic effect is now detected is due to the fact that the model is now relying on a larger number of observations (due to a longer time period) (see figure 3).

Figure 3. Fixed Broadband Economic Impact vs. Fixed Broadband penetration



Source: TAS analysis

As figure 3 indicates, now that a fixed broadband effect has been detected in Senegal, the coefficient is in line with the exponential growth curve developed on the basis of other studies.

5. CONCLUSION

The results of the models run over the third period amply confirm the hypotheses (see table 6).

Table 6. Senegal: Impact on GDP growth every 1% increase in technology penetration

	Wireless telecommunications	Fixed broadband	Wireless Broadband
First period	0.044%	No impact	No impact
Second period	0.061%	No impact	0.022%
Third period	0.091%	0.050%	0.040%

Source: TAS analysis

In sum, the results of the third wave confirm the “return to scale” effect in wireless telecommunications and wireless broadband, which stipulates that an increase in technology penetration yields higher economic contribution. In the case of fixed broadband, a longer time series has allowed the identification of an economic contribution as well.

The increase in adoption of these technologies has generated an increasing contribution to GDP growth. Table 7 depicts the average annual impact, in US dollars, of each technology.

Table 7. Senegal: Annual contribution to GDP growth (in US\$)

	Wireless Telecommunications	Fixed Broadband	Wireless Broadband
First period ⁴	US\$ 210 mm (between 2003 and 2010)	No impact	No impact
Second period ⁵	US\$ 176 mm (between 2Q05 and 2Q13)	No impact	US\$ 173 mm (between 2Q12 and 2Q13)
Third period ⁶	US\$ 251 mm (between 4Q03 and 4Q14)	US\$ 141 mm (between 4Q04 and 4Q14)	US\$ 255 mm (between 4Q13 and 4Q14)

Source: Telecom Advisory Services analysis

It is important to underline that in the last two periods, the annual impact of mobile broadband is fairly close to that of mobile telecommunications. This implies that in the first period (from 2003 to 2010), economic growth was triggered by voice telecommunications. Beyond this point, the annual impact of mobile telecommunications declines to US\$ 176 million from US\$ 210 million. This is primarily due to a decrease in the growth of voice connections. However, this decrease is amply compensated by the increase in mobile broadband connections. Therefore, the telecommunications growth contribution shifts from voice to data traffic and connections.

In the following table, the annual contribution to the senegalese GDP growth is measured in percentage points to ascertain telecommunications economic weight.

Table 8. Senegal: Contribution to GDP growth (in relationship with 2014 GDP)

	Wireless Telecommunications	Fixed Broadband	Wireless Broadband
First period	1.40%	No impact	No impact
Second period	1.17%	No impact	1.15%
Third period	1.67%	0.94%	1.69%

Source: Telecom Advisory Services analysis

The implication of these results is that the government needs to provide all the necessary incentives to increase infrastructure deployment and launch all demand stimulation mechanisms to maximize technology penetration.

⁴ *The Economic Impact of Telecommunications in Senegal*. By Dr. Raul Katz and Dr. Pantelis Koutroumpis (2012).

⁵ *Assessment of the Economic Impact of Telecommunications in Senegal*. By Dr. Raul Katz and Dr. Pantelis Koutroumpis (December 2013).

⁶ Estimates available in appendix A, B, and C in this document.

APPENDIX A: Calculation of Mobile Telecommunications Indirect Contribution to GDP in Senegal

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of mobile telecommunications to GDP growth (for a 10% increase in additional penetration)	0.91 %	Coefficient resulting from structural model
2	Mobile telecommunications penetration, Mean 2014	95.37 %	GSMA Intelligence
3	Mobile telecommunications penetration, Mean 2003	6.88 %	GSMA Intelligence
4	Compound Annual Growth Rate (CAGR) of mobile telecommunications penetration	27.01 %	$(\text{Mobile telecommunications penetration } 2014/2003)^{(1/11 \text{ years})}-1$
5	Annual impact of mobile telecommunications on GDP	2.45 %	$(\text{Annual impact})/10 * (\text{CAGR Mobile telecommunications penetration})$
6	CAGR GDP (2003-2014)	7.73 %	$(\text{GDP } 2014/\text{GDP } 2003)^{(1/11 \text{ years})}-1$
7	Percent contribution of mobile telecommunications to GDP growth	31.71 %	$\text{Annual impact of mobile telecommunications on GDP} / \text{CAGR GDP (2003-2014)}$
8	Incremental GDP growth (2014/2003)	US\$ 8,712 M	GDP 2014 - GDP 2003
9	Total impact of mobile telecommunications on incremental GDP growth	US\$ 2,763 M	$\text{Incremental GDP (2014/2003)} * \% \text{ contribution of mobile telecommunications to GDP growth}$
10	Annual impact of mobile telecommunications on GDP	US\$ 251 M	Total impact /11 years

Source: Telecom Advisory Services analysis

Appendix B. Calculation of Mobile Broadband Indirect Contribution to GDP in Senegal

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of mobile broadband to GDP growth (for a 10% increase in additional penetration)	0.40 %	Coefficient resulting from structural model
2	Mobile broadband penetration, Mean 4Q2014	8.14 %	GSMA Intelligence
3	Mobile broadband penetration, Mean 4Q2013	5.71 %	GSMA Intelligence
4	Compound Annual Growth Rate (CAGR) of mobile broadband penetration	42.74 %	$(\text{Mobile broadband penetration } 4\text{Q}2014 / 4\text{Q}2013)^{(1/1 \text{ years})} - 1$
5	Annual impact of mobile broadband on GDP	1.73 %	$(\text{Annual impact}) / 10 * (\text{CAGR Mobile broadband penetration})$
6	CAGR GDP (2013-2014)	5.33 %	$(\text{GDP } 4\text{Q}2014 / \text{GDP } 4\text{Q}2013)^{(1/1 \text{ years})} - 1$
7	Percent contribution of mobile broadband to GDP growth	32.41 %	$\text{Annual impact of mobile broadband on GDP} / \text{CAGR GDP (2013-2014)}$
8	Incremental GDP growth (2013-2014)	US\$ 788 M	$\text{GDP } 4\text{Q}2014 - \text{GDP } 4\text{Q}2013$
9	Total impact of mobile broadband on incremental GDP growth	US\$ 255 M	$\text{Incremental GDP (4Q2014/4Q2013)} * \% \text{ contribution of mobile broadband to GDP growth}$
10	Annual impact of mobile broadband on GDP	US\$ 255 M	$\text{Total impact} / 1 \text{ years}$

Source: Telecom Advisory Services analysis

Appendix C. Calculation of Fixed Broadband Indirect Contribution to GDP in Senegal

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of fixed broadband to GDP growth (for a 10% increase in additional penetration)	0.50 %	Coefficient resulting from structural model
2	Fixed broadband penetration 4Q2014	6.23%	UIT & ARTP
3	Fixed broadband penetration 4Q2004	0.63%	UIT & ARTP
4	Compound Annual Growth Rate (CAGR) of fixed broadband penetration	25.81 %	$(\text{Fixed broadband penetration } 4\text{Q}2014 / 4\text{Q}2004)^{(1/10 \text{ years})} - 1$
5	Annual impact of fixed broadband on GDP	1.28 %	$(\text{Annual impact}) / 10 * (\text{CAGR fixed broadband penetration})$
6	CAGR GDP (2004-2014)	6.84 %	$(\text{GDP } 4\text{Q}2014 / \text{GDP } 4\text{Q}2004)^{(1/10 \text{ years})} - 1$
7	Percent contribution of fixed broadband to GDP growth	18.74 %	$\text{Annual impact of fixed broadband on GDP} / \text{CAGR GDP (2004-2014)}$
8	Incremental GDP growth (2014-2004)	US\$ 7,542 M	$\text{GDP } 4\text{Q}2014 - \text{GDP } 4\text{Q}2004$
9	Total impact of fixed broadband on incremental GDP growth	US\$ 1,413 M	$\text{Incremental GDP (4Q2014/4Q2004)} * \% \text{ contribution of fixed broadband to GDP growth}$
10	Annual impact of fixed broadband on GDP	US\$ 141 M	$\text{Total impact} / 10 \text{ years}$

Source: Telecom Advisory Services analysis