FINAL REPORT

ASSESSMENT OF THE ECONOMIC IMPACT OF TELECOMMUNICATIONS IN TUNISIA

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Columbia Institute for Tele-Information

Authors

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Table of Contents

Assessment of the Economic Impact of Telecommunications in Tunisia[1]

Raul Katz

EXECUTIVE SUMMARY

The Tunisian telecommunications sector generates a significant direct and indirect impact on the country's economy, representing 4.72% of the country's 2014 GDP.

From a direct effect standpoint, the telecommunications industry gross revenues comprise 3.18% of Tunisia's economy in 2014 and 0.53% of the workforce

- Tunisia's telecommunications companies have generated in 2014 US$ 1.545 billion in revenues, which amount to US$ 364 million in fixed services and $ 1,181 in mobile telecommunications; total industry revenues represent 3.18% of the country's Gross Domestic Product.
- On the other hand, the sector generates approximately 21,000 direct and indirect jobs (representing 0.53% of the workforce in 2013).

Beyond the direct effects, telecommunications have a significant spill-over impact on the rest of the economy, generating US$ 749 million in economic value (or 1.54% of the 2014 GDP)

- Tunisia's mobile telecommunications industry has indirectly contributed US$ 524 million on average per year to the whole economy between 2003 and 2014 (1.08% of the 2014 GDP).
- On the other hand, Tunisia's fixed broadband sector has indirectly contributed US$ 225 million per annum on average between 2009 and 2014 (0.46% of the 2014 GDP).
- The contribution of telecommunications to GDP growth reached :
  - 27% between 2003 and 2014 in the case of overall mobile services (2G + 3G)
  - 23% between 2009 and 2014 in the case of fixed broadband.

Mobile telecommunications

- Tunisian mobile telecommunications have achieved a penetration of 142% (57.77% unique subscribers penetration) in 2014, enabling the delivery of multiple voice and data services (over the 2G and 3G networks).
- Combining direct and indirect effects, mobile telecommunications have an impact of US$ 1,705 million, which represent 3.51% of the Tunisian GDP in 2014.

Fixed broadband

- Fixed broadband subscriptions have reached more than 498,000 connections in 2014, enabling the delivery of multiple voice, video and data services.
- By combining direct and indirect effects, fixed broadband has an annual impact of US$ 260 million, which represent 0.53% of the Tunisian GDP in 2014.

Implications

Given the economic importance of telecommunications, public policies and regulatory frameworks need to be defined in order to maximize investment in network deployment and modernization.

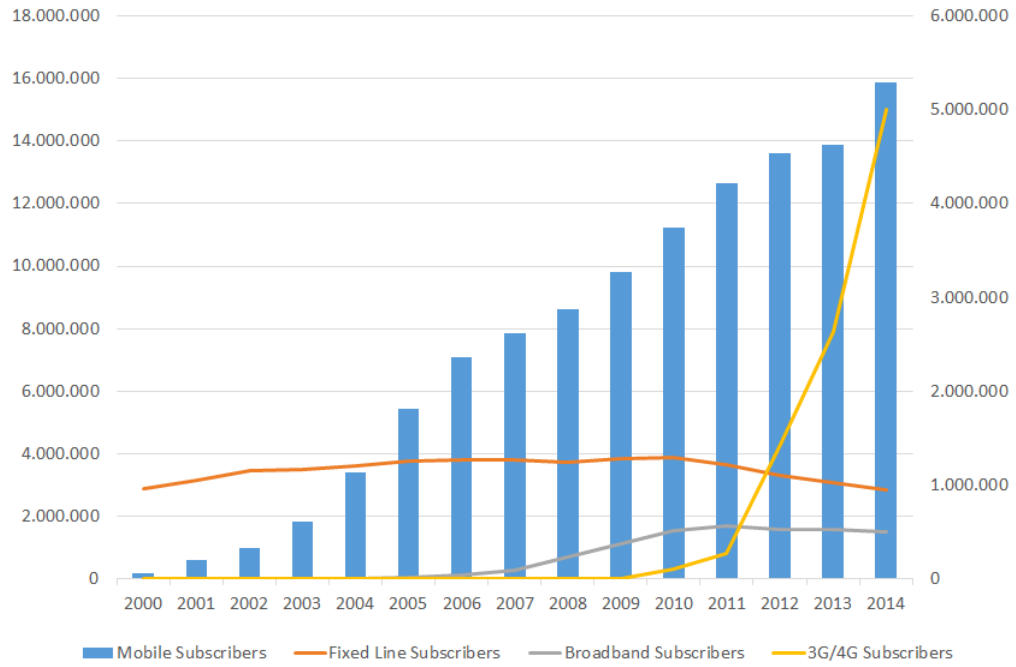
[1] Executive Summary of the study "Assessment of the Economic Impact of Telecommunications in Tunisia**"** (April 2016), conducted for Orange by Telecom Advisory Services, LCC.

1. The development of telecommunications in Tunisia and its economic importance

In 2014, the telecommunications industry revenues comprised **3.18% of the country's GDP**[2]. With more than 15.8 million connections, mobile penetration has reached 142%[3]. Tunisia mobile penetration rate is well above the regional average of 119%[4]. Additionally, fixed broadband penetration has more than 498,000 connections.

The importance of the telecommunications sector can also be validated when looking at the number of jobs it generates. In 2013, the sector comprised 11,000 direct jobs[5]. In addition, the sector triggered the creation of 10,000 indirect jobs[6]: for each direct job, telecommunications operators create 1.92 among suppliers of goods and services to the operators.

Figure 1
Tunisia: Penetration of telecommunications services (2000-2014)



Source : ITU World Telecommunication/ICT Indicators 2015; GSMA Intelligence (2015) ; Instance Nationale des Télécommunications

2. Direct and indirect effects of mobile telecommunications on the Tunisian economy

The economic effects of mobile telecommunications are proportional to the development of the wireless market with its corresponding maturity level[7]. The contribution of mobile services (2G and

[2] Sources : UIT.
[3] Source : GSMA Intelligence.
[4] Source : GSMA Intelligence.
[5] Source: UIT
[6] Source: Estimation by Telecom Advisory Services LLC based on GSMA Intelligence
[7] Gruber, H., & Koutroumpis, P. (2011). Mobile Telecommunications and the impact on Economic Development. *Telecommunications Policy*, *67*, 278-286. Kathuria, R., Uppal, M., Mamta (2009). *An Econometric Analysis of the Impact of Mobile*, The Vodafone Policy Paper Series (9), pp. 5-20. Shiu, A., & Lam, P. (2008, June 25). Relationships between Economic Growth, Telecommunications Development and Productivity Growth: Evidence around the World. In *Africa-Asia-Australasia Regional Conference of the International Telecommunications Society*. Retrieved from

mobile broadband on 3G and 4G) to economic growth is driven by the sector internal dynamics (such as the investments linked to the deployment of networks and services) and the positive externalities derived from private and enterprise use of services (*spill-over effects*). By allowing a more efficient functioning of the economy, telecommunications networks and services contribute to overall value creation.

The analysis of spill-over effects (also called indirect) of mobile telecommunications on the economy are based on a structural econometric model, composed of an aggregated production function, a demand function, a supply function, and an infrastructure function (see appendices 1 through 3).

2.1 Contribution of mobile telecommunications to Tunisian economic growth between 2003 and 2014:

- According to an econometric model developed in this study with Tunisian time series (see appendix 1), 10% increase in mobile telecommunications lines yields 1.08 % of GDP growth;
- Based on this coefficient, mobile telecommunications have contributed annually an average of US$ 524 million to Tunisia's economic growth per year between 2003 and 2014.

Table 1

Estimation of mobile telecommunications contribution to Tunisian economic growth between 2003 and 2014

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of mobile telecommunications to GDP growth (for a 10% increase in additional penetration)	1.08 %	Coefficient resulting from structural model
2	Mobile unique subscribers penetration 4Q2014	57.77 %	GSMA Intelligence
3	Mobile unique subscribers penetration 4Q2003	14.36 %	GSMA Intelligence
4	Compound Annual Growth Rate (CAGR) of mobile unique subscribers penetration	13.49 %	(Mobile unique subscribers penetration 4Q2014/4Q2003)^(1/11 years)-1
5	Annual impact of mobiles on GDP	1.45 %	(Annual impact)/10 * (CAGR Mobile Penetration)
6	CAGR GDP (2003-2014)	5.32 %	(GDP 4Q2014/GDP 4Q2003) ^ (1/11 years)-1
7	Percent contribution of mobile telecommunications to GDP growth	27.26 %	Annual impact of mobile telecommunications on GDP / CAGR GDP (2003-2014)
8	Incremental GDP growth (4Q2014/4Q2003)	US$ 21,099 M	GDP 4Q2014 - GDP 4Q2003
9	Total impact of mobile telecommunications on incremental GDP growth	US$ 5,764 M	Incremental GDP (4Q2014/4Q2003) * % contribution of mobile telecommunications to GDP growth
10	Annual impact of mobile telecommunications on GDP	US$ 524 M	Total impact /11 years

Source: Telecom Advisory Services analysis

2.2 Contribution of Mobile Broadband to Tunisia's economic growth between 2012 and 2014

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http://www.apeaweb.org/confer/hk10/papers/shiu_alice.pdf. Waverman, L., Meschi, M., Fuss, M. (2005). "The impact of telecoms on economic growth in developing countries", The Vodafone Policy paper Series (2), pp. 10-23.

- According to an econometric model developed in this study with Tunisian time series (see appendix 2), 10% increase in mobile broadband lines yields 0.20 % of GDP growth;

Despite mobile broadband impact on Tunisia's GDP, its recent launch prevents from estimating its contribution. Nevertheless, we believe this effect is already captured within the impact of mobile telecommunications (see section 2.1).

2.3 Contribution of mobile telecommunications to Tunisia's 2014 GDP

In total, mobile telecommunications represent 3.51% of Tunisia's 2014 GDP, broken down as follows:

- 2.43% represents the industry gross revenues (US$ 1,181 million) as a percentage of the country's GDP (US$ 48,533 million)
- 1.08% is the indirect contribution of mobile telecommunications, US$ 524 million in as a percentage of 2014 GDP

Table 2.

Direct and indirect contribution of mobile telecommunications to Tunisia's economic growth

	Million US$ 2014	As % of GDP
Gross revenues of mobile telecommunications operators (2014)	**1,181**	**2.43%**
Indirect contribution (spill-over) of mobile telecommunications	**524**	**1.08%**
Total impact of mobile telecommunications on Tunisia's 2014 GDP	**1,705**	**3.51%**

Source: Telecom Advisory Services analysis

3. Direct and indirect effects of fixed broadband on the Tunisian economy

3.1. Contribution of fixed broadband to Tunisia's economic growth between 2009 and 2014:

- According to an econometric model developed in this study with Tunisian time series (see appendix 3), 10% increase in fixed broadband lines yields 1.01 % of GDP growth;
- Based on this coefficient, fixed broadband has contributed annually an average of US$ 225 million to Tunisia's economic growth between 2009 and 2014.

Table 3.

Estimation of fixed broadband to Tunisian economic growth between 2009 and 2014

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of fixed broadband to GDP growth (for a 10% increase in additional penetration)	1.01 %	Coefficient resulting from structural model
2	Fixed broadband penetration 4Q2014	13.91 %	Instance Nationale des Télécommunications
3	Fixed broadband penetration 4Q2009	10.97 %	UIT
4	Compound Annual Growth Rate (CAGR) of fixed broadband penetration	4.87 %	(Fixed broadband penetration 4Q2014/4Q2009) ^(1/5 years)-1
5	Annual impact of fixed broadband on GDP	0.49 %	(Annual impact)/10 * (CAGR fixed broadband penetration)
6	CAGR GDP (2009-2014)	2.17 %	(GDP 4Q2014/ GDP 4Q2009)^(1/5 years)-1
7	Percent contribution of fixed broadband to GDP growth	22.75 %	Annual impact of fixed broadband on GDP / CAGR GDP (2009-2014)
8	Incremental GDP growth (2014-2009)	US$ 4,939 M	GDP 4Q2014 - GDP 4Q2009
9	Total impact of fixed broadband on incremental GDP growth	US$ 1,124 M	Incremental GDP (4Q2014/4Q2009) * % contribution of fixed broadband to GDP growth
10	Annual impact of fixed broadband on GDP	US$ 225 M	Total impact / 5 years

Source: Telecom Advisory Services analysis

3.2 Contribution of fixed broadband to Tunisia's 2014 GDP

In total, fixed broadband represent 0.53% of Tunisia's 2014 GDP, broken down as follows:

- 0.07% represents Tunisia's fixed broadband gross revenues (US$ 35 million) as a percentage of the country's 2014 GDP (US$ 48,533 million)
- 0.46% is the indirect contribution of fixed broadband (US$ 225 million) as a percentage of 2014 GDP

Table 4.

Direct and indirect contribution of fixed broadband to Tunisia's economic growth

	Million US$ 2014	In % of GDP
Gross revenues of fixed broadband operators (2014)	**35**	**0.07%**
Indirect contribution (spill-over) of fixed broadband	**225**	**0.46%**
Total impact of fixed broadband on Tunisia's 2014 GDP	**260**	**0.53%**

Source: Telecom Advisory Services analysis

4. Total impact of mobile telecommunications and fixed broadband on Tunisia's 2014 GDP

In sum, when considering the aggregate industry revenues and the spill-over indirect effects on the rest of the Tunisian economy, mobile telecommunications and fixed broadband have an impact of 4.72% on Tunisia's GDP.

Table 5.

Direct and indirect contribution of mobile telecommunications and fixed broadband to Tunisia's economy

		Million US$ 2014	In % of GDP
Direct Contribution (industry gross revenues)	Fixed telephony	$ 329	0.68 %
	Fixed broadband	$ 35	0.07 %
	Mobile telecommunications	$ 1,181	2.43 %
	Total	$ 1,545	3.18 %
Indirect contribution	Mobile telecommunications	$ 524	1.08 %
	Fixed broadband	$ 225	0.46 %
	Subtotal	$ 749	1.54 %
Total		$ 2,294	4.72 %
Tunisia GDP		$ 48,533	100 %

Source: Telecom Advisory Services analysis

5. Implications

The strong contribution of telecommunications to the Tunisian economy is a function of two factors:

1. The sector dynamism: the telecommunications sector is growing, generating in turn direct and indirect jobs. In fact, the operators trigger a significant number of local suppliers, distributions agents, and providers of various services, which enhance the local value added to the economy.
2. The positive externalities (« Spill-over effects »): telecommunications networks and services result in a more efficient functioning of the economy particularly in terms of:
    - Productivity gains in existing sectors (such as tourism, exports, manufacturing) as well as social services, such as education and public administration;
    - Innovation incentives, leading to the creation of new businesses in the digital economy (applications, software platforms, local content);
    - Integration of isolated regions, leading to further development of economic activities;
    - Better coordination among economic agents through improved knowledge of inputs market prices (agriculture), better coordination between economic agents resulting in low transaction costs, enhanced ability to negotiate selling prices; inventory management and delivery tracking;
    - Improvement and extension of domestic economic exchanges, as well as at the regional and global scale.

As shown in the international comparisons (in appendix 5), Tunisia is positioned among countries that have better levered telecommunications for its economic development. In this context, regulators and policy makers need to continue fostering the conditions necessary to stimulate the deployment and modernization of infrastructure, both in terms of fixed and mobile broadband. This should result in a growing adoption of broadband, both fixed and mobile, not only impacting economic activity but also delivery of social services.

ggregate production function:

$DPit=a_1K_{it}+a_2L_{it}+a_3Mob\_Pen_{it}+a_4OilPrice_{it}+ e_{it}$

emand function:

$ob\_Pen_{it}=b_1Rural_{it}+b_2Mob\_Price_{it}+b_3GDPC_{it}+b_4HHI_{it}+e_{it}$

upply function:

$'ob\_Rev_{it}=c_1MobPr_{it}+c_2GDPC_{it}+c_3HHI_{it}+\square_{3it}$

nfrastructure function:

$$\Delta Mob\_Pen_{it} = d_1 Mob\_Rev_{it} + \varepsilon_{4it}$$

Appendices

Appendix 1

Econometric model measuring the contribution of mobile telecommunications to Tunisian economic growth

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	57	18	.0088718	0.9966	19240.52	0.0000
lmobusers	57	4	.2423241	0.9537	1365.93	0.0000
lrevenuemo~e	57	3	.2663906	0.9004	610.42	0.0000
mobgrowth	57	1	.0962772	0.6396	88.55	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lgdp1						
lfcapital_3	.0631113	.0336854	1.87	0.061	-.0029108	.1291335
llabedu_1	-.1961728	.2125332	-0.92	0.356	-.6127302	.2203847
lmobusers	.1077474	.0370625	2.91	0.004	.0351062	.1803886
lnoil	.0182185	.009224	1.98	0.048	.0001397	.0362973
yr_2	-.0552041	.018177	-3.04	0.002	-.0908304	-.0195779
yr_3	-.0888612	.025598	-3.47	0.001	-.1390325	-.03869
yr_4	-.0951818	.0289987	-3.28	0.001	-.1520183	-.0383454
yr_5	-.0852786	.0328091	-2.60	0.009	-.1495834	-.0209739
yr_6	-.0995876	.0385312	-2.58	0.010	-.1751074	-.0240679
yr_7	-.0823749	.0419626	-1.96	0.050	-.1646202	-.0001296
yr_8	-.0366587	.043999	-0.83	0.405	-.1228952	.0495777
yr_9	-.0108324	.0421276	-0.26	0.797	-.0934011	.0717362
yr_10	.0191241	.0411598	0.46	0.642	-.0615477	.0997959
yr_11	.0337888	.0427182	0.79	0.429	-.0499373	.1175149
yr_12	.005356	.0439213	0.12	0.903	-.0807281	.0914402
yr_13	.0270517	.0463486	0.58	0.559	-.0637899	.1178933
yr_14	.050135	.0470192	1.07	0.286	-.0420208	.1422909
yr_15	.0709852	.0480626	1.48	0.140	-.0232158	.1651861
_cons	9.380778	.6159412	15.23	0.000	8.173556	10.588
lmobusers						
lnrural	2.170195	.4461435	4.86	0.000	1.29577	3.04462
lgdpc1	3.020386	1.10634	2.73	0.006	.8519997	5.188773
lmobcost	-.1118245	.3283777	-0.34	0.733	-.755433	.531784
hhi_mobile	-2.663461	.2525595	-10.55	0.000	-3.158469	-2.168454
_cons	39.39915	6.483287	6.08	0.000	26.69215	52.10616
lrevenuemo~e						
lgdpc1	3.024828	1.185246	2.55	0.011	.7017878	5.347868
lmobcost	.8046495	.3517575	2.29	0.022	.1152176	1.494082
hhi_mobile	-2.66219	.2710937	-9.82	0.000	-3.193524	-2.130856
_cons	59.94693	6.816433	8.79	0.000	46.58697	73.30689
mobgrowth						
lrevenuemo~e	-.1358309	.0144349	-9.41	0.000	-.1641228	-.1075391
_cons	2.733492	.2801069	9.76	0.000	2.184492	3.282491

Endogenous variables: lgdp1 lmobusers lrevenuemobile mobgrowth
Exogenous variables: lfcapital_3 llabedu_1 lnoil yr_2 yr_3 yr_4 yr_5 yr_6 yr_7 yr_8 yr_9 yr_10 yr_11 yr_12 yr_13 yr_14 yr_15 lnrural lgdpc1 lmobcost hhi_mobile

gregate production function:

$DPit=a_1K_{it}+a_2L_{it}+a_3Mob\_Bob\_Pen_{it}+a_4OilPrice_{it}+e_{it}$

nand function:

$b\_Bob\_Pen_{it}=b_1Rural_{it}+b_2Mob\_Pen_{it}+b_3Mob\_Bob\_Price_{it}+b_4GDPC_{it}+b_5HHI\_MBB_{it}+$

$BB\_PEN_{it}+e_{it}$

ply function:

$_Bob\_Rev_{it}=c_1Mob\_Bob\_Pr_{it}+c_2GDPC_{it}+c_3HHI\_MBB_{it}+\square_{it}$

astructure fu growth

riation in MBB Pen$_{it}$= d_1MBB Rev$_{it}$+$\square_{it}$

Appendix 2

Econometric model measuring the contribution of mobile broadband to Tunisian economic growth

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	18	9	.0050752	0.9795	7.84e+07	0.0000
lmbbusers	18	6	.0770461	0.9970	7274.64	0.0000
lrevenuembb	18	3	.1526143	0.9845	1197.57	0.0000
mbbgrowth	18	1	.1949577	0.0191	0.48	0.4868

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lgdp1						
lfcapital_3	.1450856	.0458037	3.17	0.002	.055312	.2348591
llabedu_1	-.2864264	.2810881	-1.02	0.308	-.837349	.2644963
lmbbusers	.0202782	.003148	6.44	0.000	.0141081	.0264482
lnoil	.0073267	.0151581	0.48	0.629	-.0223826	.037036
yr_11	9.801791	.9393219	10.43	0.000	7.960754	11.64283
yr_12	9.773851	.9374671	10.43	0.000	7.936449	11.61125
yr_13	9.773301	.9364962	10.44	0.000	7.937802	11.6088
yr_14	9.775144	.9374358	10.43	0.000	7.937804	11.61248
yr_15	9.787198	.9380011	10.43	0.000	7.94875	11.62565
_cons	(omitted)					
lmbbusers						
lfbbusers	-3.982385	.7716285	-5.16	0.000	-5.494749	-2.470021
lmobusers	1.114535	.7648085	1.46	0.145	-.3844616	2.613533
lnrural	-6.694704	18.66618	-0.36	0.720	-43.27975	29.89034
lgdpc1	5.618305	2.24581	2.50	0.012	1.216597	10.02001
lmbbcost	-3.705277	.6123635	-6.05	0.000	-4.905487	-2.505067
hhi_mb	-.7447373	.2580336	-2.89	0.004	-1.250474	-.2390007
_cons	86.72354	60.41306	1.44	0.151	-31.68387	205.131
lrevenuembb						
lgdpc1	17.206	2.698812	6.38	0.000	11.91642	22.49557
lmbbcost	-3.16331	.6010883	-5.26	0.000	-4.341421	-1.985198
hhi_mb	-.6054903	.3791695	-1.60	0.110	-1.348649	.1376683
_cons	146.272	16.35298	8.94	0.000	114.2207	178.3232
mbbgrowth						
lrevenuembb	-.0261056	.0375375	-0.70	0.487	-.0996778	.0474665
_cons	.7538324	.6810689	1.11	0.268	-.5810381	2.088703

Endogenous variables: lgdp1 lmbbusers lrevenuembb mbbgrowth
Exogenous variables: lfcapital_3 llabedu_1 lnoil yr_11 yr_12 yr_13 yr_14 yr_15 lfbbusers lmobusers lnrural lgdpc1 lmbbcost hhi_mb

gregate production function:

$GDPit=a_1K_{it}+a_2L_{it}+a_3Fix\_Bob\_Pen_{it}+a_4OilPrice_{it}+ e_{it}$

mand function:

$\_Bob\_Pen_{it}=b_1Rural_{it}+b_2Fixed\_Tel\_Pen_{it}+b_3FBB\_Price_{it}+b_4GDPC_{it}+b_5HHI\_FBB_{it}+e_{it}$

pply function:

$B\_Rev_{it}=c_1FBB\_Pr_{it}+c_2GDPC_{it}+c_3HHI\_FBB_{it}+\square_{3it}$

rastructure function:

riation in $FBB\_Pen_{it}= d_1FBB\_Rev_{it}+\square_{3it}$

Appendix 3

Econometric model measuring the contribution of fixed broadband to Tunisian economic growth

Three-stage least-squares regression

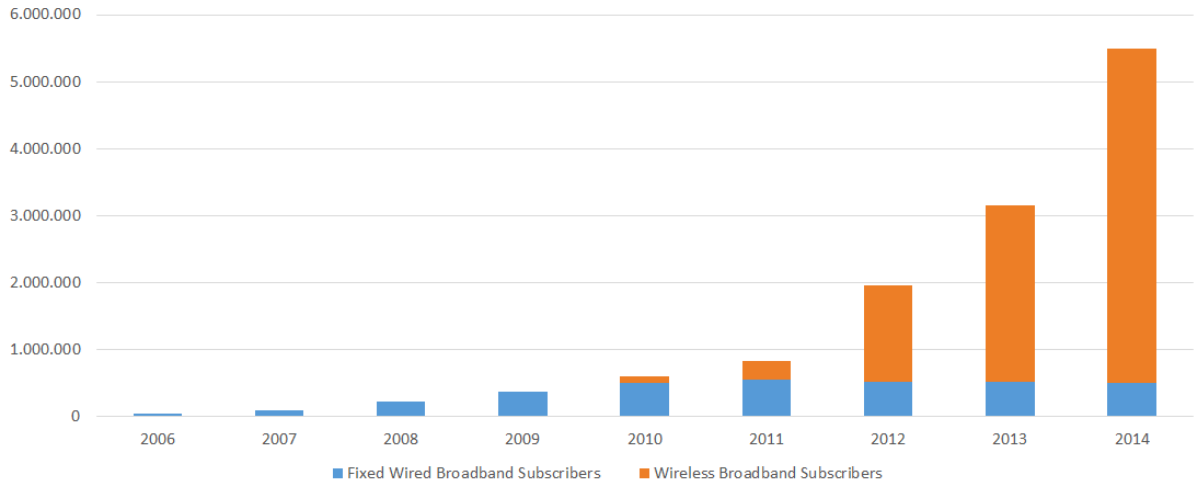
Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	37	13	.0081931	0.9890	3585.30	0.0000
lfbbusers	37	5	.1149318	0.9851	2828.02	0.0000
lrevenuefbb	37	3	.2598174	0.9141	401.09	0.0000
fbbgrowth	37	1	.0762928	0.6312	76.05	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lgdp1						
lfcapital_3	.0274233	.0417489	0.66	0.511	-.0544031	.1092496
llabedu_1	-.7114725	.2993209	-2.38	0.017	-1.298131	-.1248143
lfbbusers	.1013892	.0234446	4.32	0.000	.0554386	.1473397
lnoil	-.0020311	.0111004	-0.18	0.855	-.0237875	.0197254
yr_7	-.009757	.0111622	-0.87	0.382	-.0316345	.0121205
yr_8	.0005061	.0188984	0.03	0.979	-.036534	.0375461
yr_9	.0096738	.023094	0.42	0.675	-.0355897	.0549373
yr_10	.0040161	.028021	0.14	0.886	-.050904	.0589363
yr_11	.0174078	.0307853	0.57	0.572	-.0429302	.0777458
yr_12	-.0078756	.0325915	-0.24	0.809	-.0717536	.0560025
yr_13	.0258332	.0329826	0.78	0.433	-.0388115	.0904779
yr_14	.0562481	.0323026	1.74	0.082	-.0070638	.1195599
yr_15	.0827906	.0317604	2.61	0.009	.0205414	.1450398
_cons	11.7643	1.051399	11.19	0.000	9.703598	13.82501
lfbbusers						
lnrural	-92.01957	8.555878	-10.76	0.000	-108.7888	-75.25036
lnfixed	6.294286	.6318014	9.96	0.000	5.055978	7.532594
lgdpc1	5.889652	.9029712	6.52	0.000	4.119861	7.659443
lfbbcost	-.2420463	.2619467	-0.92	0.355	-.7554523	.2713598
hhi_fbb	-.2678582	.2029911	-1.32	0.187	-.6657135	.1299971
_cons	352.4417	24.66657	14.29	0.000	304.0961	400.7873
lrevenuefbb						
lgdpc1	14.51933	1.404453	10.34	0.000	11.76665	17.272
lfbbcost	-1.495357	.3715832	-4.02	0.000	-2.223646	-.7670672
hhi_fbb	-1.10916	.3217764	-3.45	0.001	-1.739831	-.4784903
_cons	123.3708	9.489112	13.00	0.000	104.7724	141.9691
fbbgrowth						
lrevenuefbb	-.1224333	.0140397	-8.72	0.000	-.1499507	-.0949159
_cons	2.054796	.2243884	9.16	0.000	1.615003	2.49459

Endogenous variables: lgdp1 lfbbusers lrevenuefbb fbbgrowth
Exogenous variables: lfcapital_3 llabedu_1 lnoil yr_7 yr_8 yr_9 yr_10 yr_11 yr_12 yr_13 yr_14 yr_15 lnrural lnfixed lgdpc1 lfbbcost hhi_fbb

Appendix 4

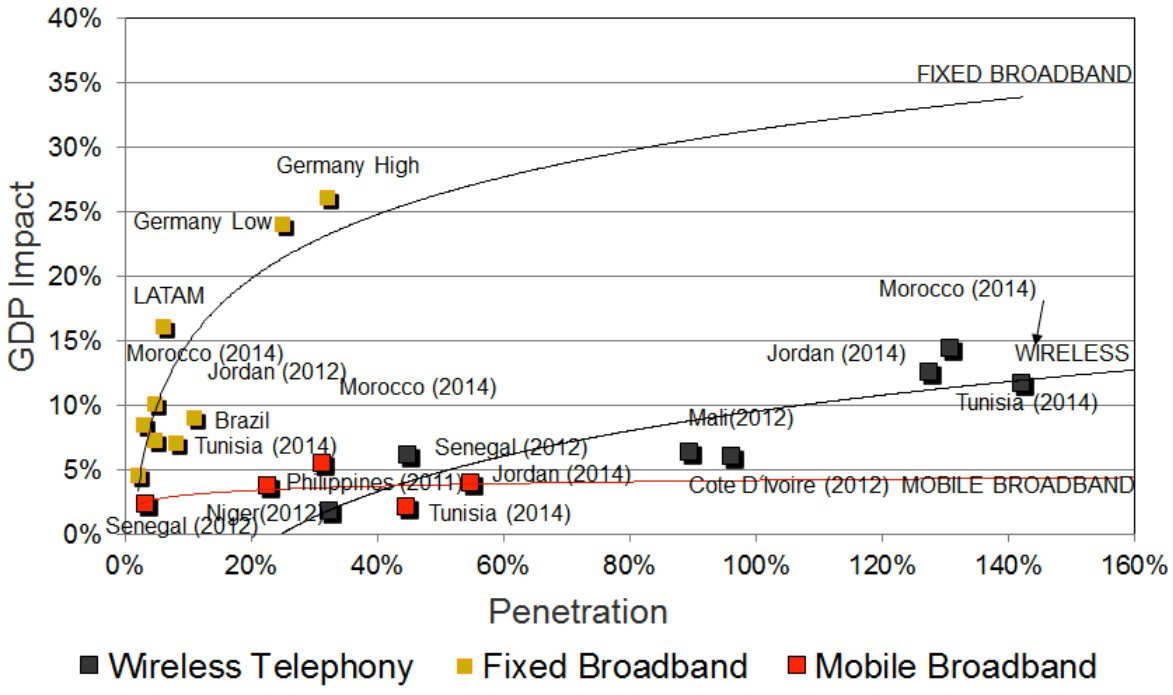
Tunisia: Penetration of fixed and mobile broadband (2006-2014)



Source : Instance Nationale des Télécommunications; GSMA Intelligence (2015) ; ITU World Telecommunication/ICT Indicators 2015

Appendix 5

Telecommunications impact on GDP growth by country



Source: TAS analysis

The chart in appendix 5 depicts three types of relationships between technology penetration and impact on GDP growth. By combining the study results on AMEA with those of prior studies conducted by the

authors, the strength of the economic impact appears to be different. First, while all three technologies (fixed broadband, wireless broadband and broadband) exercise an increasing impact on GDP growth with higher penetration, the three of them show a diminishing return effect. In other words, at a certain point of adoption of each technology, the economic impact appears to diminish (a point of diminishing returns). Second, the strength of economic impact appears to vary by technology. The highest impact appears to be linked to fixed broadband (e.g. stronger GDP growth linked to comparable penetration). However, considering that in emerging countries, mobile broadband is a substitute of fixed technology, one could assume that the economic boost related to the former might start looking more as the latter.