FINAL REPORT

ASSESSMENT OF THE ECONOMIC IMPACT OF TELECOMMUNICATIONS IN MOROCCO

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Columbia Institute for Tele-Information

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

Raul Katz

EXECUTIVE SUMMARY

The Moroccan telecommunications sector generates a significant direct and indirect impact on the country's economy, representing 5.88% of the country's 2014 GDP.

From a direct effect standpoint, the telecommunications industry gross revenues comprise 3.73% of Morocco's economy in 2014 and 0.45% of the workforce

- Morocco's telecommunications companies have generated in 2014 US$ 4.072 billion in revenues, which amount to US$ 149 million in fixed services and $ 3.923 in mobile telecommunications; total industry revenues represent 3.73% of the country's Gross Domestic Product.
- On the other hand, the sector generates approximately 55,500 direct and indirect jobs (representing 0.45% of the workforce in 2013).

Beyond the direct effects, telecommunications have a significant spill-over impact on the rest of the economy, generating US$ 2,347 million in economic value (or 2.15% of the 2014 GDP)

- Morocco's mobile telecommunications industry has indirectly contributed US$ 1,597 million on average per year to the whole economy between 2001 and 2014 (1.46% of the 2014 GDP).
- On the other hand, Morocco's fixed broadband sector has indirectly contributed US$ 750 million per annum on average between 2006 and 2014 (0.69% of the 2014 GDP).
- The contribution of telecommunications to GDP growth reached :
  - 29% between 2001 and 2014 in the case of overall mobile services (2G + 3G)
  - 37% between 2011 and 2014 in the case of broadband mobile
  - 14% between 2006 and 2014 in the case of fixed broadband.

Mobile telecommunications

- Moroccan mobile telecommunications have achieved a penetration of 131% in 2014, enabling the delivery of multiple voice and data services (over the 2G and 3G networks).
- Combining direct and indirect effects, mobile telecommunications (2G and 3G) have an impact of US$ 5,520 million, which represent 5.05% of the Moroccan GDP in 2014.
- Mobile broadband services alone have generated annual economic value of US$ 1,234 million on average between 2011 and 2014 (which represents 1.13% of the 2014 GDP)

Fixed broadband

- Fixed broadband subscriptions have reached a penetration of 14% of households 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$ 872 million, which represent 0.80% of the Moroccan 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, particularly in mobile broadband.

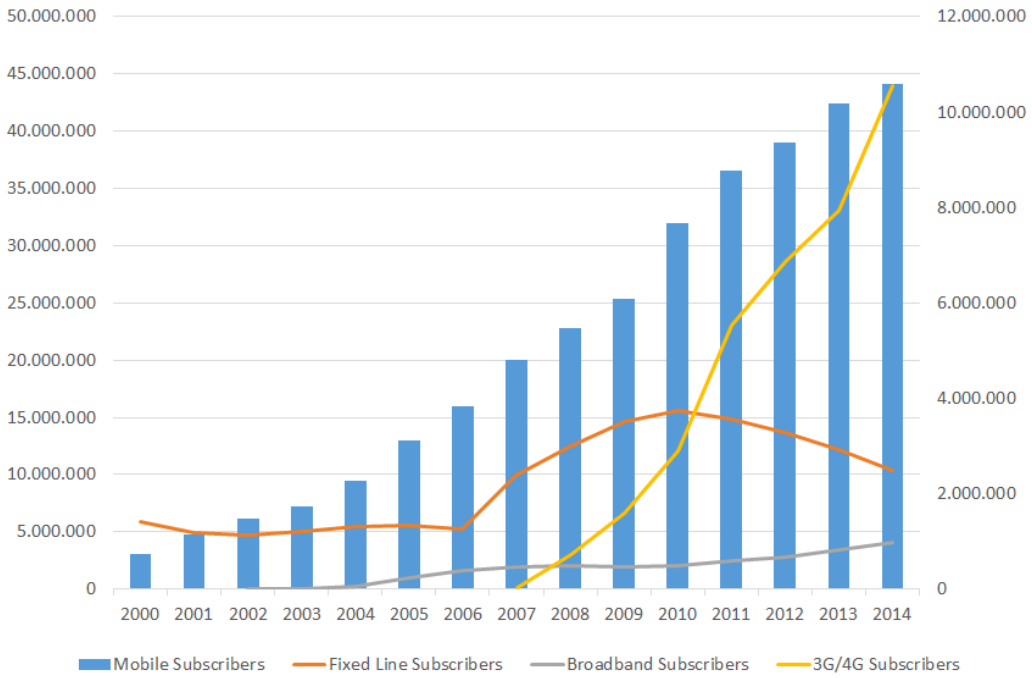
[1] Executive Summary of the study "Assessment of the Economic Impact of Telecommunications in Morocco" (April 2016), conducted for Orange by Telecom Advisory Services, LCC.

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

In 2014, the telecommunications industry revenues comprised **3.73% of the country's GDP**[2]. With more than 44.1 million connections, mobile penetration has reached 131%[3]. Morocco mobile penetration rate is well above the regional average of 119%[4]. Additionally, fixed broadband penetration has reached 14% of Moroccan households.

The importance of the telecommunications sector can also be validated when looking at the number of jobs it generates. In 2013, the sector comprised 13,500 direct jobs[5]. In addition, the sector triggered the creation of 42,000 indirect jobs[6]: for each direct job, telecommunications operators create 3.11 among suppliers of goods and services to the operators.

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



Sources: ITU World Telecommunication/ICT Indicators 2015; ANRT; GSMA Intelligence (2015)

2. Direct and indirect effects of mobile telecommunications on the Moroccan 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 and information from operators.
[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 telecommunication to Moroccan economic growth between 2001 and 2004:

- According to an econometric model developed in this study with Moroccan time series (see appendix 1), 10% increase in mobile telecommunications lines yields 1.43 % of GDP growth;
- Based on this coefficient, mobile telecommunications have contributed annually an average of US$ 1,597 million to Morocco's economic growth per year between 2001 and 2014.

Table 1

Estimation of mobile telecommunications contribution to Moroccan economic growth between 2001 and 2014 [8]

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of mobile telecommunications to GDP growth (for a 10% increase in additional penetration)	1.43 %	Coefficient resulting from structural model
2	Mobile penetration 4Q2014	130.81 %	GSMA Intelligence
3	Mobile penetration 4Q2001	16.50 %	GSMA Intelligence
4	Compound Annual Growth Rate (CAGR) of mobile penetration	17.26 %	(Mobile penetration 4Q2014/4Q2001)^(1/13 years)-1
5	Annual impact of mobiles on GDP	2.47 %	(Annual impact)/10 * (CAGR Mobile Penetration)
6	CAGR GDP (2001-2014)	8.52 %	(GDP 4Q2014/GDP 4Q2001) ^ (1/13 years)-1
7	Percent contribution of mobile telecommunications to GDP growth	29.05 %	Annual impact of mobile telecommunications on GDP / CAGR GDP (2001-2014)
8	Incremental GDP growth (4Q2014/4Q2001)	US$ 71,476 M	GDP 4Q2014 - GDP 4Q2001
9	Total impact of mobile telecommunications on incremental GDP growth	US$ 20,761 M	Incremental GDP (4Q2014/4Q2001) * % contribution of mobile telecommunications to GDP growth
10	Annual impact of mobile telecommunications on GDP	US$ 1,597 M	Total impact /13 years

Source: Telecom Advisory Services analysis

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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.

[8] This impact coefficient includes mobile broadband as well.

2.2 Contribution of Mobile Broadband to Morocco's economic growth between 2011 and 2014

- According to an econometric model developed in this study with Moroccan time series (see appendix 2), 10% increase in mobile broadband lines yields 0.54 % of GDP growth;
- Based on this coefficient, mobile broadband have contributed annually an average of US$ 1,234 million to Morocco's economic growth between 2011 and 2014.

Table 2

Estimation of mobile broadband contribution to Moroccan economic growth between 2011 and 2014

Item	Factor	Value	Source and / or estimation formula
1	Annual contribution of mobile broadband to GDP growth (for a 10% increase in additional penetration)	0.54 %	Coefficient resulting from structural model
2	Mobile broadband penetration 4Q2014	31.27 %	GSMA Intelligence
3	Mobile broadband penetration 4Q2011	17.12 %	GSMA Intelligence
4	Compound Annual Growth Rate (CAGR) of mobile broadband penetration	22.24 %	(Mobile broadband penetration 4Q2014/4Q2011) ^(1/3 years)-1
5	Annual impact of mobile broadband on GDP	1.20 %	(Annual impact)/10 * (CAGR Mobile broadband penetration)
6	CAGR GDP (2011-2014)	3.25 %	(GDP 4Q2014/ GDP 4Q2011)^(1/3 years)-1
7	Percent contribution of mobile broadband to GDP growth	37.05 %	Annual impact of mobile broadband on GDP / CAGR GDP (2011-2014)
8	Incremental GDP growth (2011-2014)	US$ 9,990 M	GDP 4Q2014- GDP 4Q2011
9	Total impact of mobile broadband on incremental GDP growth	US$ 3,701 M	Incremental GDP (4Q2014/4Q2011) * % contribution of mobile broadband to GDP growth
10	Annual impact of mobile broadband on GDP	US$ 1,234 M	Total impact / 3 years

Source: Telecom Advisory Services analysis

It should be mentioned that the impact of mobile broadband is already included in the contribution of mobile telecommunications (see section 2.1).

2.3 Contribution of mobile telecommunications to Morocco's 2014 GDP

In total, mobile telecommunications represent 5.05% of Morocco's 2014 GDP, broken down as follows:

- 3.59% represents the industry gross revenues (US$ 3,923 million) as a percentage of the country's GDP (US$ 109,201 million)
- 1.46% is the indirect contribution of mobile telecommunications (US$ 1,597 million) as a percentage of 2014 GDP.

Table 3.

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

	Million US$ 2014	As % of GDP
Gross revenues of mobile telecommunications operators (2014)	**3,923**	**3.59%**
Indirect contribution (spill-over) of mobile telecommunications	**1,597**	**1.46%**
Total impact of mobile telecommunications on Morocco's 2014 GDP	**5,520**	**5.05%**

Source: Telecom Advisory Services analysis

These estimates are consistent with those developed by other analysts, where for each 1.4% of direct economic effects of mobile telecommunications on the GDP, 2.5% of indirect effects are generated[9].

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

3.1. **Contribution of fixed broadband to Morocco's economic growth between 2006 and 2004:**

- According to an econometric model developed in this study with Moroccan time series (see appendix 3), 10% increase in fixed broadband lines yields 0.84 % of GDP growth;
- Based on this coefficient, fixed broadband has contributed annually an average of US$ 750 million to Morocco's economic growth between 2006 and 2014.

Table 4.

Estimation of fixed broadband contribution to Moroccan economic growth between 2006 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)	0.84 %	Coefficient resulting from structural model
2	Fixed broadband penetration 4Q2014	14.15 %	ANRT
3	Fixed broadband penetration 4Q2006	6.25 %	UIT
4	Compound Annual Growth Rate (CAGR) of fixed broadband penetration	10.76 %	(Fixed broadband penetration 4Q2014/1Q2006) ^(1/8 years)-1
5	Annual impact of fixed broadband on GDP	0.90 %	(Annual impact)/10 * (CAGR fixed broadband penetration)
6	CAGR GDP (2006-2014)	6.57 %	(GDP 4Q2014/ GDP 4Q2006)^(1/8 years)-1
7	Percent contribution of fixed broadband to GDP growth	13.77 %	Annual impact of fixed broadband on GDP / CAGR GDP (2006-2014)
8	Incremental GDP growth (2014-2006)	US$ 43,561 M	GDP 4Q2014 - GDP 4Q2006
9	Total impact of fixed broadband on incremental GDP growth	US$ 6,000 M	Incremental GDP (4Q2014/1Q2006) * % contribution of fixed broadband to GDP growth
10	Annual impact of fixed broadband on GDP	US$ 750 M	Total impact / 8 years

Source: Telecom Advisory Services analysis

3.2 Contribution of fixed broadband to Morocco's 2014 GDP

In total, fixed broadband represent 0.80% of Morocco's 2014 GDP, broken down as follows:

- 0.11% represents Morocco's fixed broadband gross revenues (US$ 122 million) as a percentage of the country's 2014 GDP (US$ 109,201 million)
- 0.69% is the indirect contribution of fixed broadband (US$ 750 million) as a percentage of 2014 GDP

[9] See Deloitte (2014). *The mobile economy*. London: GSMA.

Table 5.

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

	Million US$ 2014	In % of GDP
Gross revenues of fixed broadband operators (2014)	**122**	**0.11%**
Indirect contribution (spill-over) of fixed broadband	**750**	**0.69%**
Total impact of fixed broadband on Morocco's 2014 GDP	**872**	**0.80%**

Source: Telecom Advisory Services analysis

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

In sum, when considering the aggregate industry revenues and the spill-over indirect effects on the rest of the Moroccan economy, mobile telecommunications and fixed broadband have an impact of 5.88% on Morocco's GDP.

Table 6.

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

		Million US$ 2014	In % of GDP
Direct contribution (Industry Gross revenues)	Fixed telephony	$ 27	0.03 %
	Fixed broadband	$ 122	0.11 %
	Mobile telecommunications	$ 3,923	3.59 %
	Total	$ 4,072	3.73 %
Indirect contribution	Mobile telecommunications	$ 1,597	1.46 %
	Fixed broadband	$ 750	0.69 %
	Subtotal	$ 2,347	2.15 %
Total		$ 6,419	5.88%
Morocco GDP		$ 109,201	100 %

Source: Telecom Advisory Services analysis

5. Implications

The strong contribution of telecommunications to the Moroccan 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), Morocco 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.

Appendices

Appendix 1

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

Aggregate production function:

$GDPit=a_1K_{it}+a_2L_{it}+a_3Mob\_Pen_{it}+ a_4Shock_{it}+e_{it}$

Demand function:

$Mob\_Pen_{it}=b_1Rural_{it}+b_2Fixed_{it}+b_3Mob\_Price_{it}+b_4GDPC_{it}+b_5HHI_{it}+e_{it}$

Supply function:

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

Infrastructure function:

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

```
. reg3 (lgdp1 lfcapital_3 llabedu_1 lmobusers primavera2 yr_6-yr_15 ) (lmobusers lnrural lnfixed lgdp
> c1  lmobcost hhi_mobile) (lrevenuemobile lgdpc1 lmobcost hhi_mobile) (mobgrowth lrevenuemobile) if
> yr>2005 | (yr >2004 & qt>3)

Three-stage least-squares regression
```

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
lgdp1	37	13	.0079495	0.9979	19619.13	0.0000
lmobusers	37	5	.0387255	0.9880	4066.34	0.0000
lrevenuemo~e	37	3	.0390407	0.9722	1337.82	0.0000
mobgrowth	37	1	.0272389	0.1064	7.03	0.0080

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
lgdp1						
lfcapital_3	.5164588	.061403	8.41	0.000	.3961112	.6368064
llabedu_1	.1670606	.1022323	1.63	0.102	-.0333111	.3674322
lmobusers	.1433419	.0625775	2.29	0.022	.0206922	.2659916
primavera2	-.0136336	.0073017	-1.87	0.062	-.0279448	.0006775
yr_6	-.0046694	.0282157	-0.17	0.869	-.0599711	.0506323
yr_7	.0016054	.0249325	0.06	0.949	-.0472613	.0504722
yr_8	-.008189	.0207612	-0.39	0.693	-.0488801	.0325022
yr_9	-.0031611	.0183737	-0.17	0.863	-.0391729	.0328507
yr_10	.0171095	.014904	1.15	0.251	-.0121018	.0463207
yr_11	.0105448	.0090002	1.17	0.241	-.0070953	.0281849
yr_12	(omitted)					
yr_13	-.0244753	.0077048	-3.18	0.001	-.0395765	-.0093741
yr_14	-.0079258	.0092193	-0.86	0.390	-.0259954	.0101437
yr_15	.0312151	.0108593	2.87	0.004	.0099313	.0524988
_cons	-1.352781	.3356156	-4.03	0.000	-2.010576	-.6949865
lmobusers						
lnrural	-2.322509	1.109013	-2.09	0.036	-4.496135	-.1488832
lnfixed	.0860207	.0339769	2.53	0.011	.0194272	.1526143
lgdpc1	.8911315	.1771286	5.03	0.000	.5439659	1.238297
lmobcost	-.0354179	.0870982	-0.41	0.684	-.2061272	.1352913
hhi_mobile	-.6758909	.103324	-6.54	0.000	-.8784022	-.4733796
_cons	12.91373	4.519072	2.86	0.004	4.056515	21.77095
lrevenuemo~e						
lgdpc1	1.390007	.0729559	19.05	0.000	1.247016	1.532998
lmobcost	.8291106	.0871102	9.52	0.000	.6583777	.9998435
hhi_mobile	-.8725899	.0897652	-9.72	0.000	-1.048526	-.6966534
_cons	16.83843	.9394508	17.92	0.000	14.99714	18.67972
mobgrowth						
lrevenuemo~e	-.0504817	.0190341	-2.65	0.008	-.0877878	-.0131756
_cons	1.066326	.389812	2.74	0.006	.3023082	1.830343

```
Endogenous variables:  lgdp1 lmobusers lrevenuemobile mobgrowth
Exogenous variables:   lfcapital_3 llabedu_1 primavera2 yr_6 yr_7 yr_8 yr_9
     yr_10 yr_11 yr_12 yr_13 yr_14 yr_15 lnrural lnfixed lgdpc1 lmobcost
     hhi_mobile
```

Appendix 2

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

Aggregate production function:

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

Demand function:

$Mob\_Bob\_Pen_{it}=b_1FBB\_Pen_{it}+b_2Mob\_Pen_{it}+b_3Mob\_Bob\_Price_{it}+b_4GDPC_{it}+b_5HHI\_MBB_{it}+e_{it}$

Supply function:

$Mob\_Bob\_Rev_{it}=c_1Mob\_Bob\_Pr_{it}+c_2GDPC_{it}+c_3HHI\_MBB_{it}+\square_{3it}$

Infrastructure function:

$Variation\ in\ MBB\_Pen_{it}= d_1MBB\_Rev_{it}+\square_{3it}$

```
. reg3 (lgdp1 lfcapital_3 llabedu_1 lmbbusers  yr_11-yr_15) (lmbbusers lmobusers lfbbusers   lgdpc1
> lmbbcost hhi_mb)     (lrevenuembb    lgdpc1 lmbbcost hhi_mb)     (mbbgrowth lrevenuembb)

Three-stage least-squares regression
------------------------------------------------------------------------------
Equation           Obs   Parms        RMSE    "R-sq"       chi2         P
------------------------------------------------------------------------------
lgdp1               18       8    .0030597    0.9968   2.10e+07    0.0000
lmbbusers           18       5     .079871    0.9572     449.01    0.0000
lrevenuembb         18       3    .1132402    0.8906     148.13    0.0000
mbbgrowth           18       1    .0683231    0.0074       0.99    0.3189
------------------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lgdp1        |
 lfcapital_3 |    1.78021   .1030613    17.27   0.000     1.578213    1.982206
   llabedu_1 |   -.839823   .0856092    -9.81   0.000    -1.007614   -.6720321
   lmbbusers |   .0541444   .0127535     4.25   0.000      .029148    .0791408
        yr_11 |  -6.416927   .5719322   -11.22   0.000    -7.537894   -5.295961
        yr_12 |   -6.41873   .5716253   -11.23   0.000    -7.539095   -5.298365
        yr_13 |  -6.430542   .5704631   -11.27   0.000    -7.548629   -5.312455
        yr_14 |  -6.438692    .571374   -11.27   0.000    -7.558564   -5.318819
        yr_15 |  -6.433555   .5719983   -11.25   0.000    -7.554651   -5.312459
        _cons |  (omitted)
-------------+----------------------------------------------------------------
lmbbusers    |
   lmobusers |   4.234589   .6043939     7.01   0.000     3.049999     5.41918
   lfbbusers |   -1.10417   .3821251    -2.89   0.004    -1.853122   -.3552187
      lgdpc1 |   .2238495   1.190083     0.19   0.851    -2.108671    2.55637
    lmbbcost |  -.4494617    .189812    -2.37   0.018    -.8214863   -.0774371
      hhi_mb |   1.145904   1.273565     0.90   0.368    -1.350238    3.642045
       _cons |  -26.65321   9.386776    -2.84   0.005    -45.05096   -8.255468
-------------+----------------------------------------------------------------
lrevenuembb  |
      lgdpc1 |   3.132327   1.638031     1.91   0.056    -.0781541    6.342808
    lmbbcost |   -.212624   .1395278    -1.52   0.128    -.4860935    .0608454
      hhi_mb |   10.78122   1.786293     6.04   0.000     7.280146    14.28229
       _cons |  -90.63119   12.41478    -7.30   0.000    -114.9637   -66.29866
-------------+----------------------------------------------------------------
mbbgrowth    |
 lrevenuembb |  -.0480837   .0482382    -1.00   0.319    -.1426288    .0464614
       _cons |   .9331593   .8444628     1.11   0.269    -.7219574    2.588276
------------------------------------------------------------------------------
Endogenous variables:  lgdp1 lmbbusers lrevenuembb mbbgrowth
Exogenous variables:   lfcapital_3 llabedu_1 yr_11 yr_12 yr_13 yr_14 yr_15
     lmobusers lfbbusers lgdpc1 lmbbcost hhi_mb
------------------------------------------------------------------------------
```

Appendix 3

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

Aggregate production function:

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

Demand function:

$Fix\_Bob\_Pen_{it}=b_1Rural_{it}+b_2Fixed\_Tel\_Pen_{it}+b_3FBB\_Price_{it}+b_4GDPC_{it}+b_5HHI\_FBB_{it}+b_6MBB\_Pen_{it}+e_{it}$

Supply function:

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

Infrastructure function:

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

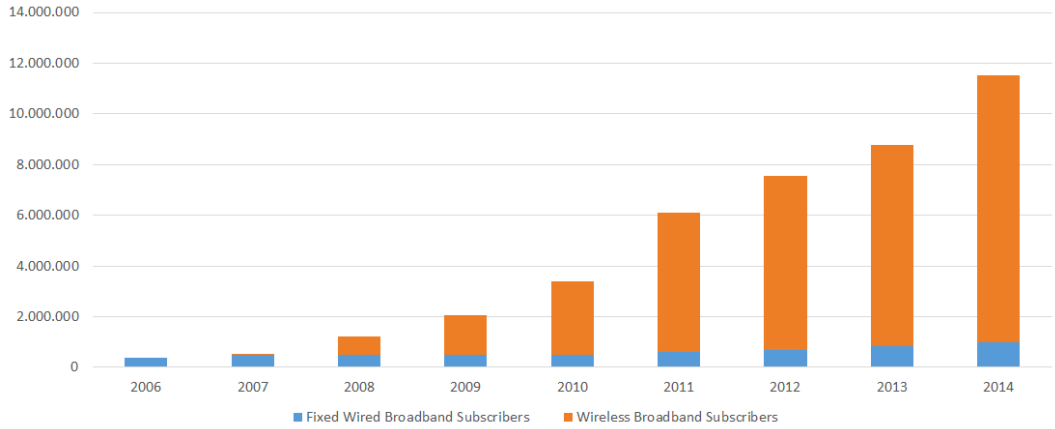
```
. reg3 (lgdp1 lfcapital_3 llabedu_1 lfbbusers  yr_10-yr_15 ) (lfbbusers  lmbbusers lnrural lnfixed lg
> dpc1  lfbbcost hhi_fbb)    (lrevenuefbb    lgdpc1 lfbbcost hhi_fbb)    (fbbgrowth lrevenuefbb) if y
> r>2009

Three-stage least-squares regression
------------------------------------------------------------------------------
Equation           Obs  Parms        RMSE    "R-sq"       chi2         P
------------------------------------------------------------------------------
lgdp1               20      7    .0053624    0.9913    2372.19    0.0000
lfbbusers           20      6    .0092147    0.9982   12131.17    0.0000
lrevenuefbb         20      3    .0449892    0.6837      54.72    0.0000
fbbgrowth           20      1    .0191042    0.0132       3.33    0.0682
------------------------------------------------------------------------------

------------------------------------------------------------------------------
             |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
lgdp1        |
 lfcapital_3 |   1.243297   .1633139     7.61   0.000      .923208    1.563387
   llabedu_1 |  -.2071316   .1012369    -2.05   0.041    -.4055522    -.008711
   lfbbusers |   .0840642   .0425875     1.97   0.048     .0005943    .1675342
       yr_10 |  (omitted)
       yr_11 |   .0075135   .0184933     0.41   0.685    -.0287328    .0437597
       yr_12 |   .0088832    .016553     0.54   0.592    -.0235601    .0413265
       yr_13 |  -.0110266   .0127643    -0.86   0.388    -.0360442     .013991
       yr_14 |   -.014658    .007098    -2.07   0.039    -.0285698   -.0007462
       yr_15 |  (omitted)
       _cons |  -4.517016   .9135615    -4.94   0.000    -6.307564   -2.726468
-------------+----------------------------------------------------------------
lfbbusers    |
   lmbbusers |   .0168601    .038111     0.44   0.658    -.0578361    .0915563
     lnrural |  -5.698085   2.167674    -2.63   0.009    -9.946649   -1.449521
     lnfixed |   -.718536   .1541008    -4.66   0.000    -1.020568    -.416504
      lgdpc1 |   .6945729   .1592029     4.36   0.000      .382541    1.006605
    lfbbcost |  -.0765007   .0554237    -1.38   0.167    -.1851291    .0321277
     hhi_fbb |   -1.34772   .2932718    -4.60   0.000    -1.922522   -.7729177
       _cons |    31.2544   6.560955     4.76   0.000     18.39516    44.11363
-------------+----------------------------------------------------------------
lrevenuefbb  |
      lgdpc1 |   1.568325   .6883007     2.28   0.023     .2192801    2.917369
    lfbbcost |  -.0146431   .1096959    -0.13   0.894    -.2296432     .200357
     hhi_fbb |   .0108446   1.011025     0.01   0.991    -1.970729    1.992418
       _cons |   6.657234      6.516     1.02   0.307     -6.11389    19.42836
-------------+----------------------------------------------------------------
fbbgrowth    |
 lrevenuefbb |   .0927377    .050847     1.82   0.068    -.0069206     .192396
       _cons |  -1.554156   .8702949    -1.79   0.074    -3.259902     .151591
------------------------------------------------------------------------------
Endogenous variables:  lgdp1 lfbbusers lrevenuefbb fbbgrowth
Exogenous variables:   lfcapital_3 llabedu_1 yr_10 yr_11 yr_12 yr_13 yr_14
     yr_15 lmbbusers lnrural lnfixed lgdpc1 lfbbcost hhi_fbb
------------------------------------------------------------------------------
```

Appendix 4

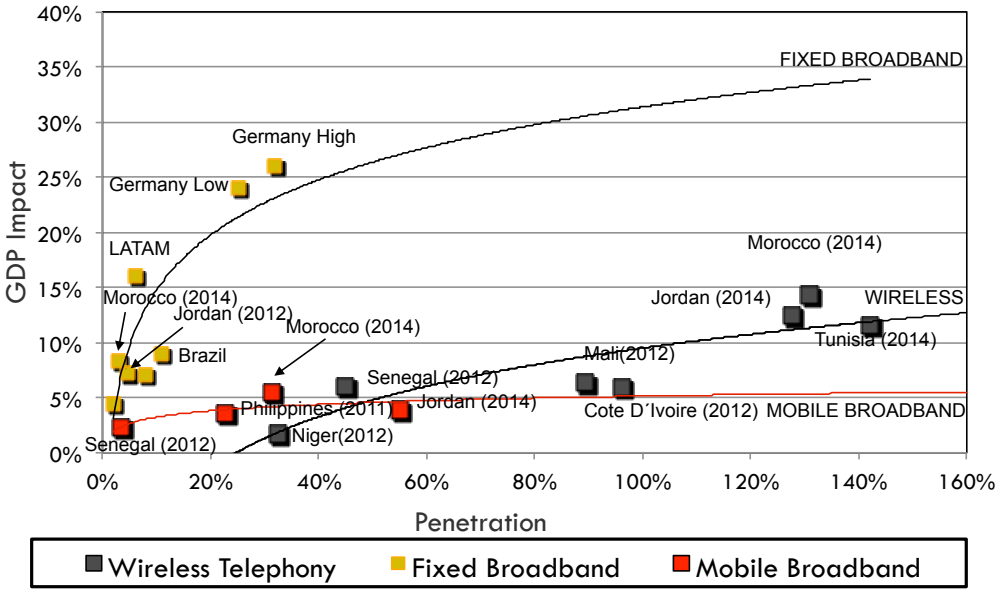
Morocco: Penetration of fixed and mobile broadband (2006-2014)



Sources: ITU World Telecommunication/ICT Indicators 2015; ANRT; GSMA Intelligence (2015)

Appendix 5

Comparative impact of telecommunications on GDP growth



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.