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P E R S P E C T I V E P A P E R

*Benefits and Costs of the Infrastructure Targets  
for the Post-2015 Development Agenda*

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# Benefits and Costs of the Infrastructure Targets for the Post-2015 Development Agenda

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Post-2015 Consensus

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## Background

The economic impact of broadband infrastructure as a general-purpose technology is well recognized. As a typical productive infrastructural investment, broadband network deployment produces spillover effects to most sectors of the national economy. The transformative nature of the technology results in business process restructuring, higher productivity gains and informed decision making. As a direct means of reducing the information asymmetry broadband networks act as innovation incubators facilitating the quick creation of new businesses thus lowering the entry and exit barriers. Besides, constant improvements in the service and equipment offerings lead to new business models and enhance existing multipliers. Easing the access to process and operation outsourcing helps smaller businesses improve their core strengths while not risking their positions in the market.

Less than a decade ago, broadband connections were thin on the ground. Research on the economic impact of broadband started to emerge towards the end of the 2000's when adoption rates increased and the first coherent datasets became available. Most studies looked at the advanced economies including the OECD, European countries and the US. The methodological frameworks that have been used in this process range from simple or detailed surveys of firms and households to panel data on the coverage and use of broadband networks. The core methodological constraint in this strand of works is the lack of detailed micro-data. For this purpose researchers either used aggregate national statistics or carefully collected survey samples. Put simply, a bottom up approach with all the micro-data was not possible or has not been used before. To challenge this shortcoming surveys have focused on understanding the potential uses of the technology. In terms of national level statistics the most common shortcoming of studies looking into the economic effects of broadband networks is to account for the existence of reverse causality. This means that one needs to isolate the effect of the network on economic output while controlling for the reverse effect as well.

Several studies have managed to produce meaningful outcomes. Nevertheless the number and quality of controls introduced in each model are never easy to weigh or rank in a strict way. The World Bank produced one of the earliest studies on the impact of broadband on economic growth (Qiang & Rosotto, 2009). This work looks at a sample of 66 high-income economies for the period 1980-2002, when in fact broadband was quite scarce and only the Republic of Korea, Canada and Hong Kong had achieved adoption levels beyond the 10%. It finds that – other things being equal – every additional 10% of the population that subscribes to broadband will increase the national GDP by 1.21% during that period. Studies that looked into the same effects for more recent periods have generally found more conservative figures for the same effects. For example Koutroumpis (2009) looks into an OECD sample for the period 2002-2007 and finds a strongly positive and significant link for the impact of broadband adoption on GDP expansion. The results suggest that the 'average' country in the dataset benefited from broadband adoption by an annual rate of 0.25% of GDP. This is equal to 10% of all GDP growth for these countries during 2002-2007. Czernich et al (2011) performed a similar exercise looking at a broader OECD sample

between 1996 and 2007. They confirm that broadband adoption has a positive impact on national output and estimate this effect to increase by 0.9%-1.5% for every 10% increase in broadband penetration. The last two studies control for reverse causality in explicit ways; they introduce structural models that disentangle the effects and perform several robustness checks.

Since the impact of the broadband infrastructure affects the economy, it is important to understand the routes to this impact as these stem from a wide range of effects. As in all infrastructural investments the direct construction effects are the first to be realized. Once the equipment has been put in place the adoption and usage intensity of the networks start to materialize. New firms are created and existing ones tap into the new potential brought about by broadband. The literature suggests that the increase of broadband adoption at the local level helps create new businesses but net-employment is not always affected due to displacement effects. Upon reaching a critical mass broadband adoption exhibits increasing returns to scale while the 'expected' benefits take years to materialize. More frequently the types of impacts are summarized in three broad categories. There are:

- 'direct' impacts on employment and GDP associated with the telecommunications companies (telcos) undertaking the investment
- 'indirect' impacts on employment and GDP associated with telcos' supply chains – that is, the businesses from which the telcos purchase equipment such as optical fibre cable and electronics, and services such as civil engineering work, and in turn, those suppliers' supply chains
- 'induced' impacts on employment and GDP in the wider economy, as a result of the additional employees in telcos and their suppliers spending their wages in the local and national economies (e.g. retail, entertainment, accommodation expenditure).

One should be careful in the assessment of future broadband effects as these depend on a number of parameters. First the level and structure of each economy (resource-driven, production-driven or innovation driven) plays a key role in the envisaged effects. Second the local socio-political conditions are also linked to the potential benefits. In fact institutions and regulation are the key enablers that help realize the economic effects of broadband networks. Governance affects ICT impacts from the micro-levels (management and organizational flexibility) to the macro-levels (rule of law, corruption and freedom). In this sense any model that attempts to forecast the impact of broadband technologies has to take into account the technical, social and political parameters that come along with this undertaking. To this end it is essential to acknowledge that ICT related goals should include a set of internet governance policies to help policy-makers evaluate the progress of each region and its future potential.

## **Overview and assessment of general requirements of "Post 2015 Consensus Research Brief"**

After the background work on the subject I turn to the assessment paper prepared by Auriol and Fanfalone on the ICT infrastructure goals for the Post-2015 Agenda. The authors make a credible effort to analyze an inherently complex undertaking. In fact the approach

entails both the choice of the goals and the assessment of the costs and benefits – aspects that in isolation require much deeper analysis and very specific knowledge of the underlying conditions. For example European countries that have already embarked in forward-looking studies for broadband developments have devoted months and the delivery of confidential information for similar assessments<sup>1</sup>. With these factors in mind I review the original paper. First, I find the focus on broadband indicators a valid step forward. Given that technologies change over time and the envisaged plan spans over fifteen years the authors used a triptych of parameters (availability, quality and affordability) as their guiding targets. The availability component is translated as coverage – i.e. being able to get connected rather than actually being connected – the quality mainly deals with speed and the affordability is not extensively analyzed – especially in a developing country context.

When measuring the costs and benefits of the targets I find that broadband penetration is only used instead of the aforementioned angles (availability, quality, affordability). Broadband penetration is a proxy of network adoption and use instead of coverage, speeds or prices. The list of targets presented is the following:

- Increase world fixed broadband penetration by three-fold
- Increase fixed broadband penetration around three-fold in developing regions
- Increase world mobile broadband penetration around three-fold
- Increase mobile broadband around three-fold in the developing regions
- 100% Fixed + Mobile broadband penetration (World and developing regions)
- Universal Fixed Broadband penetration (World and developing regions)
- Universal Mobile broadband penetration (World and developing regions)

One of the most common benchmarks of broadband targets, speed, is excluded from this list. Essentially the adoption goal is treated homogeneously for both fixed and mobile penetration. If that was the case there would be hardly any requirement for the developed world where xDSL and Cable technologies are abundant. In practice policy-makers have targeted Next-Generation-Networks that often require substantial investments to meet their broadband plans. Moreover one would have expected a higher effect from fiber network deployment that allows for increased speeds and lower latency; instead in the original paper I only find a fixed impact across technologies thus making the cheaper ones score higher in terms of the cost-benefit approach. This is in line with expectations but could have been explained in a more informative – for the readers and policymakers – way.

## **Assessment of the methodology and cost-benefit estimates**

Moving further into the particular methodologies used I quote the authors that mention: “...this study focuses on one dimension of broadband, its availability, measured in terms of penetration. This would allow for targets to be concise and measurable.” My understanding is that broadband availability does not guarantee its adoption – i.e. the fact that the networks will be built does not mean that these will be used. I think this needs to

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<sup>1</sup> EU: Digital Agenda, UK national broadband plan, Germany Breitband Atlas, US National Broadband Plan, etc.

address the potential economic impacts from non-users in developing countries. A recent study (Ahlfeldt et al , 2014) estimates that connecting the un-connected yields orders of magnitude the economic benefits from simply upgrading existing subscribers to higher speeds. The key question here is: will these non-users actually take up the service? This is far more complicated to answer.

Another concern is linked to the choice of the targets rather than the final goals per se. Clearly any target would be under criticism but I am mostly worried about the motivation of the targets. For example what is the relative impact of a 10% increase in broadband for Least Developed Countries and what for other developing or developed ones? Why should one include all countries instead of the ones mostly in need for intervention? And more specifically: Why are these specific goals important? The key takeaway of this exercise is to efficiently bind the infrastructural challenges with other targets in the Post-2015 Agenda. The targets should somehow reflect these challenges. For example adding 10% of broadband in LDCs can have a range of effects across the Post-2015 Agenda: reduce poverty (Challenge area 1), increase access to education (Challenge area 3), improve health monitoring, prevent outbreaks of epidemics (Challenge area 4) and invest in local infrastructure (Challenge area 11). This might not be true for all countries and regions. Essentially the goals should form a matrix where each unit of investment has a different effect depending on the country – or even smaller geographical area – of interest. This is a more complicated exercise that – among others – requires detailed information that is not always available.

Cognizant of the difficulties in this exercise I discuss the use of existing estimates for the impact of broadband networks on national output in this study's context. To my understanding the application of estimates on GDP impact from developed country studies is not a safe option to forecast future benefits in the developing world. The type of use in a developing country context can be very different. The impact of ICT in this context is presented in a number of studies (Jensen, 2007; Aker, 2011; Muto and Yamano, 2011). Moreover their impact as a general-purpose technology may be underestimated in the cost benefit analysis. For example the impact of broadband on health, education, poverty and the replication effects on rudimentary infrastructures (financial services, local transportation, market performance through reducing information asymmetries for remote areas, etc) can not be accurately measured. For example a series of studies in West African countries found considerable heterogeneity across them: the impact of mobile broadband in Senegal was estimated at 0.21% GDP for each 10% increase in adoption<sup>2</sup>. However the impact of simple mobile phone penetration in Niger – let alone broadband – is not statistically significant. This realization makes the use of “off the shelf” estimates particularly difficult especially in a different socio-economic context.

Given that the final deliverable of the original paper is a cost-benefit analysis one has to look in detail both in the expected benefits and the estimated costs. As with the previous

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<sup>2</sup> Katz, Raul L., and Pantelis Koutroumpis. " Assessment of the economic impact of Telecommunications in francophone West Africa ", Columbia Institute of Tele-Information, 2014.

observation the cost assessment is based on developed country figures that can be misleading. Moreover the range of technologies examined seems to imply that population density and local labor costs have not been accounted for. Additionally some cost-effective technologies have not been taken into account (i.e. satellite and 3G mobile broadband). The existence or lack of a telecommunications regulatory authority and the cost of spectrum licensing and rights of way have also not been discussed. All these can have a dramatic impact on the final costs. One typical example was presented in the first cost assessment of the Digital Agenda for Europe in 2011. Looking in disaggregated information at the NUTS-5 level of EU regions the European Investment Bank published a report suggesting that the goals of the Digital Agenda for Europe can be achieved with a range of scenarios that cost from 73 bn Euros to 221 bn Euros (Hatonen 2011, Gruber et al 2014). This three-fold difference underlines that even the same goals can have an enormous variation when interpreted in a thorough techno-economic evaluation. Notably the EU Digital Agenda targets specify speeds and adoption levels compared to the current set of targets. This makes the interpretation even harder for policy-makers.

Expanding on the cost-related arguments it is particularly important to think about the technologies together with the user interfaces. Mobile broadband is perhaps the best alternative as smartphones and tablets are both user-friendly, have long battery life and work directly with the existing infrastructure without additional equipment requirements (satellite dish, fixed broadband router, etc). For remote areas satellite access should also be considered as an alternative. Parameters like equipment damage and theft should also be discussed in this section.

Finally, the authors acknowledge the need for backbone networks but in their cost assessment this is not reflected. This is a minor change that could improve their paper. Moreover the choice of technologies is not analyzed (although mentioned in the cost section). Older mobile technologies (3G/4G) are perhaps a more cost-effective way forward.

## **Suggestions for improvement**

The developing world has generally experienced higher adoption rates of prepaid mobile phone services. A reasonable next step would need to highlight a transition strategy from mobile voice to broadband. This may include content and applications that reflect the local needs and ensure a higher interest in the new technology.

The focus of the target is least developed countries (LDCs) but these are never analyzed nor mentioned in the report. A straightforward step would be to list the countries and their present economic conditions, the existence of a government or regulator that can help with this deployment and an assessment of other local characteristics (industrial mix, education level, etc). For example the current status in fixed and mobile broadband should be analyzed in combination with the surrounding ecosystem. I briefly look at these countries in the following section.

In a nutshell my suggestion is the following: list the target countries, assess whether their current political situation allows an intervention of this kind, measure the costs based on a range of easily deployed and maintained technologies and examine the spectrum of applications for each economy that broadband will affect (agriculture, health, trade, access to information, etc). My suggestion is that it is not possible to complete this task with the given resources and the current cost-benefit approach provides a simplified solution to a very complex problem.

## **An alternative scenario through a bottom-up approach**

The first step in designing the strategy for 2030 is to look into the current status based on the best available data. LDCs include 48 countries and their current fixed broadband penetration, mobile cellular (voice) penetration, and internet users are presented in Table 1. Out of the 900 million people residing in LDCs only 6.7% are internet users as estimated by the Broadband Commission (2013). Fixed line networks are rudimentary (0.44% only have a fixed broadband connection) making a fixed broadband strategy an unlikely solution. Mobiles have already got a substantial footprint in these countries where almost 60% of the population uses a mobile device. These simple observations can act as a driver for the assessment of infrastructural costs and the strategy to achieve quick adoption of the services.

There are several advantages in favor of this approach:

1. Infrastructure cost: Upgrading existing infrastructure mobile broadband (3G/LTE) requires much less investment per capita. Upgrades over copper and cable networks are meaningful in cases where most of the population can be reached through the legacy infrastructure. Hence the quoted – in the original paper – cost of VDSL at 400 EUR/home represents the upgrade rather than the build up costs.
2. User experience: In most LDCs users are accustomed to mobile phones. Building on this experience policy-makers can achieve more important goals in the context of Post-2015 Agenda that help the local population trade their products, access information and receive health services. This can play an important role in the adoption process as we have seen in the developing world too.
3. Devices: Low cost laptops and tablets are already widely available hence the “entry costs” may not be prohibitive. In fact there is practical experience in this context by an organization called “One laptop per child” and led by Nicholas Negroponte. Ministries in the developing world collaborate with this organization to improve access to educational material and the provision of low-cost internet access.

Let’s assume that both the network infrastructure and the devices can be fully or partly subsidized for LDCs. These can immediately help challenge the following Post-2015 Agenda targets:

1. Health: smartphones with a range of screening tests and simple upgrades (like cartridge readers and improved lenses) can help detect cardiovascular and peripheral vascular disease, virulent pathogens like HIV, hepatitis B and H1N1 (swine) flu<sup>3</sup>, blood imaging can help detect malaria<sup>4</sup> and biofilms can test blood coagulation<sup>5</sup> for patients. All these can have a dramatic effect in terms of diagnosis, cure and overall health of the local population. Broadband infrastructure can help in this direction as the results of these tests can be sent from rural parts to the hospitals for immediate response.
2. Education: There is already a long effort by the One Laptop per Child organization in this front; the development of broadband networks can further help in this direction and increase its scope. The provision of educational material through broadband connections should be combined with the provision of other necessary resources (acceptable conditions at schools and training of teachers) in the Post-2015 Agenda.
3. Transportation: building on local needs, transportation services can be improved based on real time and on-demand services for remote areas. This can reduce costs and improve efficiency of these services.

In spite of the benefits, supplying broadband to LDCs poses a number of substantial challenges. These are described below:

1. Spectrum rights: this needs coordination from the local ministries and regulators as spectrum rights often require substantial investments for the provision of broadband services.
2. Satellite access for remote areas: access to the internet for remote areas might not be possible with mobile broadband hence satellite services should also be considered.
3. Equipment: there is a need to protect the equipment (base station, cables) as these might be damaged or stolen. A number of redundancies should also be put in place.
4. Control over content: it is common in several countries that freedom of internet access is not guaranteed. To succeed in this goal one needs to be sure about internet governance policies in place.

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<sup>3</sup> <http://egr.uri.edu/the-blood-test-app/>

<sup>4</sup> <http://www.medgadget.com/2014/08/athelas-blood-imager-on-your-smartphone-for-automatic-malaria-diagnosis.html>

<sup>5</sup> <http://www.medgadget.com/2014/03/blood-coagulation-testing-using-smartphone-touchscreens.html>

*Table 1: Current conditions in Least Developed Countries (Source Broadband Commission 2013)*

Country Name	Fixed broadband Internet subscribers (per 100 people)	Mobile cellular subscriptions (per 100 people)	Population	Internet users (%)
Afghanistan	0.00	70.00	30,551,674	5.45
Angola	0.22	61.87	21,471,618	16.94
Bangladesh	0.63	67.08	156,594,962	6.3
Benin	0.04	93.26	10,323,474	3.8
Bhutan	2.72	72.20	753,947	25.43
Burkina Faso	0.08	66.38	16,934,839	3.73
Burundi	0.00	24.96	10,162,532	1.22
Cambodia	0.22	133.89	15,135,169	4.94
Central African Republic	0.00	29.47	4,616,417	3
Chad	0.12	35.56	12,825,314	2.1
Comoros	0.18	47.28	734,917	5.98
Congo, Dem. Rep.	0.01	43.70	67,513,677	1.68
Djibouti	2.03	27.97	872,932	8.27
Equatorial Guinea	0.46	67.47	757,014	13.94
Eritrea	0.00	5.60	6,333,135	0.8
Ethiopia	0.25	27.25	94,100,756	1.48
Gambia, The	0.02	99.98	1,849,285	12.45
Guinea	0.01	63.32	11,745,189	1.49
Guinea-Bissau	0.00	74.09	1,704,255	2.89
Haiti		69.40	10,317,461	10.87
Kiribati	1.07	16.61	102,351	10.75
Lao PDR	0.13	66.20	6,769,727	10.75
Lesotho	0.11	86.30	2,074,465	4.59
Liberia	0.00	59.51	4,294,077	3.79
Madagascar	0.06	36.13	22,924,851	2.05
Malawi	0.02	32.33	16,362,567	4.35
Mali	0.02	129.07	15,301,650	2.17
Mauritania	0.19	102.53	3,889,880	5.37
Mozambique	0.07	48.00	25,833,752	4.85
Myanmar	0.18	12.83	53,259,018	1.07
Nepal	0.75	71.46	27,797,457	11.15
Niger	0.04	39.29	17,831,270	1.41
Rwanda	0.02	56.80	11,776,522	8.02
Sao Tome and Principe	0.51	64.94	192,993	21.57
Samoa	0.11		190,372	12.92
Senegal	0.76	92.93	14,133,280	19.2
Sierra Leone		44.13	6,092,075	1.3
Solomon Islands	0.34	57.57	561,231	7
Somalia	0.57	49.38	10,495,583	1.38
South Sudan	0.00	25.26	11,296,173	
Sudan	0.12	72.85	37,964,306	21

Tanzania	0.11	55.72	49,253,126	13.08
Timor-Leste	0.06	57.38	1,178,252	0.91
Togo	0.10	62.53	6,816,982	4
Tuvalu	7.09	34.43	9,876	35
Uganda	0.11	44.09	37,578,876	14.69
Vanuatu	0.12	59.34	252,763	10.6
Yemen, Rep.	1.05	69.01	24,407,381	17.45
Zambia	0.07	71.50	14,538,640	13.47
<b>Least developed countries (UN classification)</b>	0.44	58.31	898,478,063	6.72

## Conclusion

The goal of this paper is to assess the cost-benefit estimates of the Auriol and Fanfalone paper on the ICT infrastructure goals for the Post-2015 Agenda and provide suggestions for improvement. In this process I find the focus on broadband penetration a valid strategy and explain my views on the targets and their key assumptions. The authors have clearly explained that their estimates are subject to a number of simplified assumptions. From my standpoint I propose a simplified approach to a complex problem. Combining this information can inform policy-makers about the validity of this undertaking. These suggestions are clearly open to further scrutiny.

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This paper was written by Pantelis Koutroumpis, Research Fellow at Imperial College London. The project brings together 60 teams of economists with NGOs, international agencies and businesses to identify the targets with the greatest benefit-to-cost ratio for the UN's post-2015 development goals.

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