The economic impact of broadband in Panama

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This report is part of a new series of ITU reports on broadband that are available online and free of charge at the Broadband Commission website: http://www.broadbandcommission.org/ and ITU Universe of Broadband portal: www.itu.int/broadband.

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Preface

The past twenty years have been an extraordinary time for the development of information and communication technologies (ICTs) – with the 'mobile miracle', we have brought the benefits of ICTs within reach of virtually all the world's people. Through its technical standardization and spectrum management work, ITU has been at the forefront of technological change and is today committed to continue to drive positive change in the ICT sector and beyond. It is now time to make the next step, and to ensure that everyone – wherever they live, and whatever their circumstances – has access to the benefits of broadband. This is not just about delivering connectivity for connectivity's sake, or even about giving people access to the undoubted benefits of social communications. It is about leveraging the power of broadband technologies, and especially mobile technologies, to make the world a better place.

In 2010, ITU, in conjunction with UNESCO, launched the Broadband Commission for Digital Development to boost the importance of broadband on the international policy agenda and believes that expanding broadband access in every country is key to accelerating progress towards these goals by the target date of 2015. The Commission is co-chaired by President Paul Kagame of Rwanda and Carlos Slim Helú, President of the Carlos Slim Foundation. Some 60 Broadband Commissioners representing governments, industry, academia and international agencies contribute the benefit of their insights and experience to the Commission's work. At the Broadband Leadership Summit held in October 2011 in Geneva, the Broadband Commission recognized broadband as a critical modern infrastructure contributing to economic growth and set four clear, new targets for making broadband policy universal and for boosting affordability and broadband uptake. Innovative new models that promote competition, innovation and market growth are now needed to make the broadband opportunity reachable for all world citizens.

At ITU, the United Nations specialized agency for ICTs and telecommunications, we are committed to playing a leading role in the development of the digital economy through extending the benefits of advances in broadband and embracing the opportunities it unleashes. The three ITU sectors – Radiocommunication, Standardization and Development – are working together to meet these challenges and our collective success will be a key factor in ensuring the provision of equitable broadband access throughout the world. The ITU Broadband Reports represent one tangible contribution towards this commitment.

Dr Hamadoun I. Touré
Secretary-General, ITU

Foreword

Broadband has become a key priority of the 21st Century, and I believe its transformative power as an enabler for economic and social growth makes it an essential tool for empowering people, creating an environment that nurtures the technological and service innovation, and triggering positive change in business processes as well as in society as a whole. Increased adoption and use of broadband in the next decade and beyond will be driven by the extent to which broadband-supported services and applications are not only made available to, but are also relevant and affordable for consumers. And while the benefits of broadband-enabled future are manifest, the broadband revolution has raised up new issues and challenges.

In light of these developments, ITU launches a new series of ITU Broadband Reports. The first reports in the series launched in 2012 focus on cutting edge policy, regulatory and economic aspects of broadband. Other related areas and themes will be covered by subsequent reports including market analysis, broadband infrastructure and implementation, and broadband-enabled applications. In addition, a series of case studies will complement the resources already made available by ITU to all its many different types of readers, but especially to ICT regulators and policy-makers.

This new series of reports is important for a number of reasons. First of all, the reports will focus on topical issues of special interest for developed and developing countries alike. Secondly, the various reports build on ITU's recognized expertise in the area augmented by regular feedback from its Membership. Last but not least, this series is important because it provides a meaningful contribution to the work of the Broadband Commission for Digital Development. The findings of the ITU Broadband Reports will trace paths towards the timely achievement of the ambitious but achievable goals set recently by the Commission as well as provide concrete guidelines. As broadband is a field that's growing very fast, we need to constantly build knowledge for our economies and societies to thrive and evolve into the future.

For these reasons, I am proud to inaugurate this first series of the ITU Broadband Reports and look forward to furthering ITU's work on the dynamic and exciting broadband ecosystem.

Brahima Sanou

Director, ITU Telecommunication Development Bureau

Executive Summary

This study assesses the economic impact of broadband in an emerging nation. Drawing from the wealth of research literature on economic effects generated on the basis of cross-sectional analyses (e.g. for OECD, Latin America and Arab States), it applies econometric tools and techniques to measure the impact of broadband on the Panamanian economy.

The Panamanian telecommunication sector accounts for 3.0% (or US $892 million) of the country's Gross Domestic Product (GDP), directly contributing US $107 million annually to its economic growth, and generating 3.7% of total tax collections. In addition, the sector represents more than 1.2% of all employment (or some 15,900 direct jobs) in the country.

The evidence suggests that fixed broadband has a significant economic impact in Panama. The model developed for the period 2000-2010 estimates that fixed broadband indirectly contributed 0.44% annually to GDP. Given the annual growth rate of the Panamanian economy at 4.6%, the indirect effects of fixed broadband usage contributed almost 9.6% of all economic growth in the country. Furthermore, since 2005 this impact has almost doubled reaching 0.82% of GDP and representing 11.3% of all economic growth. The increasing impact of fixed broadband on the Panamanian economy reflects the concept of increasing returns to scale experienced both in fixed and mobile networks across the world.

The future of broadband in Panama is not only linked to fixed access. Current adoption of mobile broadband is split between mobile phones with access to the Internet and dedicated mobile broadband services (PCs connected through USB modems, aircards, etc.). The former account for almost 4.2% of per capita (Q4 2011)[1] penetration, while the latter less than 0.05%. Adoption of dedicated mobile broadband offerings in Panama was scarce until 2010, suggesting an insignificant contribution on GDP growth. However, 45.4% of the Panamanian population is forecast to adopt mobile broadband connections by 2016[2]. Given the significant impact of fixed broadband, it is expected that mobile broadband will also contribute to the growth of the Panamanian economy. Additionally, the mobility attributes of 3G and LTE connections can help serve the rural and remote parts of the country, thereby reducing social exclusion, increasing digital literacy and connecting these areas to the rest of the world.

Future challenges for Panama include applying the lessons learned from wireless voice services to fixed broadband, and by leveraging its highly competitive industry structure, to accelerate mobile broadband adoption. Wireless broadband represents the appropriate technological platform to meet this challenge. Its deployment will facilitate the development of domestic and export-oriented economic activity. In parallel, the development of applications in the areas of education, public health, media, entertainment and government services, will act as incentives to broadband adoption.

[1] Source: Wireless Intelligence (2012)

[2] Source: Wireless Intelligence (2012)

1. Introduction

Since the mid-1970s, social scientists and policy-makers have been researching the contribution of information and communication technologies (ICTs) to economic development[3]. In fact, ever since the first studies conducted by researchers of the World Bank and development agencies, social scientists have been developing tools and techniques to measure the impact of telecommunications on GDP growth, employment creation and productivity, among other metrics.

Until recently, the primary statistical approach to test the economic contribution of ICT has been based on the study of cross-sectional samples of countries. Due to limitations on data availability, the primary emphasis has been on OECD countries (facilitated by the extensive Eurostat data sets) or worldwide analysis (based on ITU statistical indicators). While this approach is still pursued[4], researchers are starting to focus their assessments on specific country studies. For example, aiming to understand the economic impact of broadband, in the past three years we have conducted studies for Germany (Katz et al., 2010a), the United States (Katz and Suter, 2009a; Katz et al, 2011a), Costa Rica (Katz, 2011e), Chile (Katz, 2010c), Colombia (Katz, 2011e), Peru (Katz, 2011f) and Senegal (Katz and Koutroumpis, 2012).

This study seeks to assess the economic impact of broadband in Panama. It analyses the relative impact of fixed and mobile broadband communications. The measureable economic impact of ICT infrastructure depends heavily on the timing of introduction, existing adoption conditions and market maturity. As studies of the lagged impact of ICT have demonstrated (Hardy, 1980; Jorgenson et al., 2006; Karner and Onyeji, 2007), the significant economic impact of ICT does not materialize immediately after the introduction of a new technology.

Broadband services represent a market that has contributed to the evolution of the Panamanian economy during the last decade. To measure this contribution, a structural model, relying on four equations that model the market operation was constructed. The equations addressed:

- Endogenous growth from existing capital and labour together with broadband infrastructural metrics;
- Demand for broadband services depending on the price and adoption patterns;
- Supply and competition of broadband taking into account the regulatory and infrastructural investments in ICT; and
- Revenues and output of the broadband market as a proxy for the 'health' and sustainability of the sector.

This study begins by providing a brief review of the research literature regarding the impact of broadband on the economy (Section 2). The review of the literature provides a context for the development of the approach utilized in the case study. The study begins by providing first a view of the primary features of the Panamanian economy (Section 3) and then the key dynamics of the local telecommunications market are explained (Section 4). The results of the econometric model are presented and discussed in section 5. The implications from a public policy standpoint are drawn in Section 6.

[3] See, for example, Madden, G. and Savage, S.J. (1998), Marsch, D. (1976), Norton, S.W. (1992), and Schapiro, P. (1976).

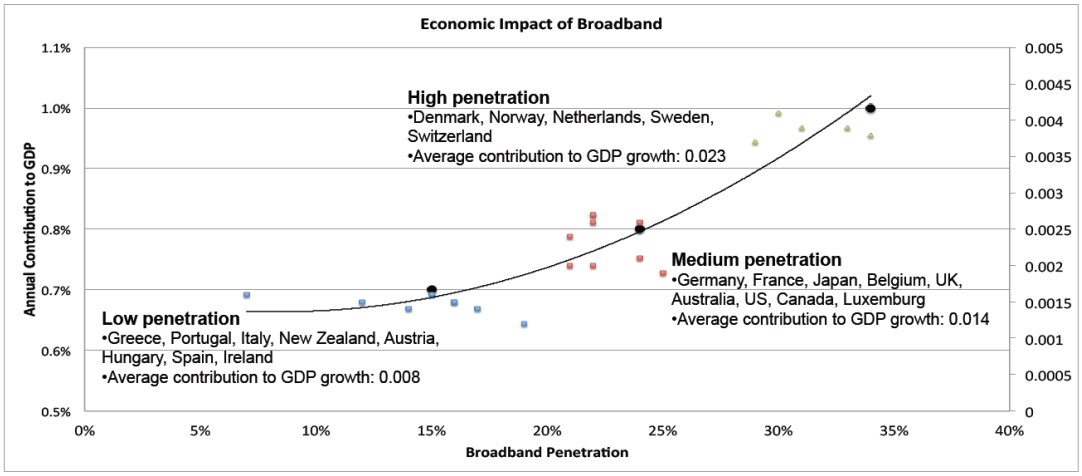
[4] See Koutroumpis (2009), Waverman (2009) and Katz (2009d).

2. The Impact of Broadband on the Economy, Jobs and Welfare

Broadband contributes to economic growth initially by producing a series of effects similar to those generated by infrastructure deployment. Beyond the benefits for GDP growth, it also has significant economic impact on consumer surplus. Some of these effects — such as the impact of investment on infrastructure — have been estimated quantitatively through input-output analyses. Others, such as the impact on productivity growth and the elasticity of supply, as well as multipliers of household income, have not yet been studied in detail. However, beyond this chain of causality, research in developed countries has begun to generate evidence of causality between broadband and growth, as well as the microeconomic effects broadband can have on business productivity.

Using data from OECD countries, two studies have evaluated the impact of broadband on GDP growth. The first analyzed this impact in 25 OECD countries between 1996 and 2007 (Czernich et al., 2009). The authors determined that the adoption of broadband was statistically significant in regard to the rise in per capita GDP, with a ratio of 1.9% to 2.5%. Koutroumpis (2009) tried to solve the underlying problem of reverse causality between GDP and infrastructural investments by constructing a structural model with simultaneous equations (Figure 1). His analysis focused on 22 OECD countries over the period 2002-2007. Again, the results indicated that there is a statistically significant relationship. The author also determined that broadband's contribution to GDP growth increases with its diffusion due to network effects: in countries with low penetration rates (less than 20%), a 10 percentage point increase leads to a 0.7% GDP growth; in countries with an average degree of penetration (between 20% and 30%), the effect is 0.8%; while in countries with high penetration rates (over 30%), the impact on GDP growth rate is almost 1%. A list of similar studies is presented in Table 1.

Figure 1: Broadband contribution to growth in developed countries



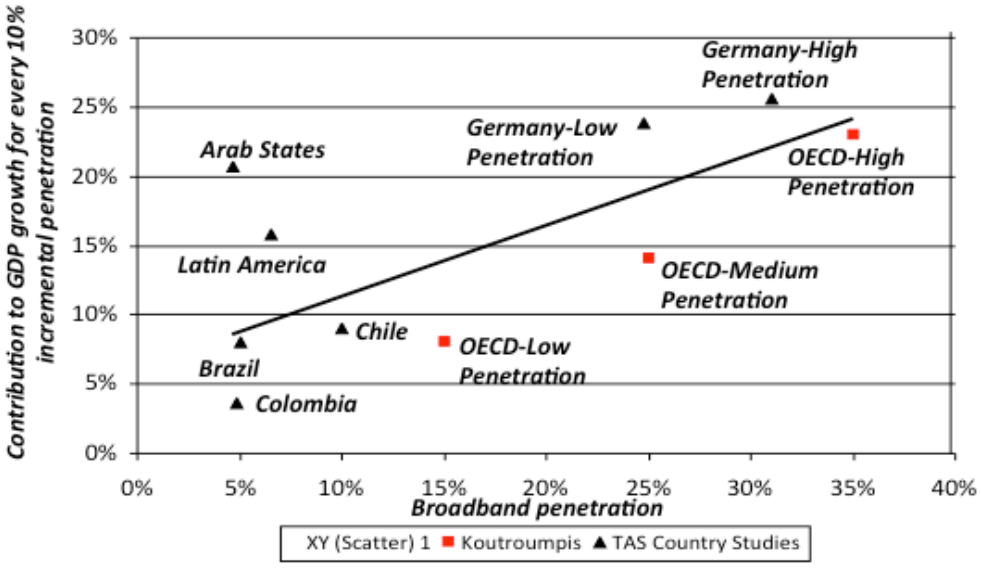
Source: adapted from Koutroumpis (2009)

Table 1: Research results regarding the impact of broadband on growth

Country/Region	Study	Data	Impact
United States	Crandall et al. (2007)	48 states in the United States, 2003-2005	No statistically significant impact on GDP growth
	Thompson et al. (2008)	46 states in the United States, 2001-2005	A 10% increase in broadband penetration was linked to a 3.6% increase in efficiency
OECD	Czernich et al. (2009)	25 OECD countries, 1996-2007	Broadband adoption elevated per capita GDP by between 1.9 % and 2.5%
	Koutroumpis (2009)	22 OECD countries, 2002-2007	A 10 percentage point increase in broadband penetration produced between 0.7% and 1% increase in GDP growth
Germany	Katz et al. (2010a)	424 counties in Germany, 2000-2006	A 10% increase in broadband penetration produced a 0.255% increase in GDP growth
Developed countries	Qiang et al. (2009)	Developed counties from a sampling of 120 countries, 1980-2002	A 10% increase in broadband penetration produced a 1.21% increase in GDP growth
Low- and middle-income countries	Qiang et al. (2009)	Remaining countries (low- and middle-income developing economies) from a sampling of 120 countries, 1980-2002	A 10% increase in broadband penetration contributed 1.38% to economic growth

The incremental impact of broadband penetration is increasingly validated by a recent study published by one of these authors (Katz, 2011), where countries with lower broadband penetration tend to exhibit a lesser contribution of broadband to economic growth.

Figure 2: Broadband contribution to growth versus broadband penetration



Source: Katz (2011)

Beyond the impact on economic growth, researchers have also studied the subsequent effects of network externalities on employment variously categorized as "innovation", or "network effects"[5]. The study of network externalities resulting from greater broadband penetration has led to the identification of numerous effects:

- Introduction of new and innovative applications and services, such as telemedicine, Internet search, e-commerce, online education and social networking[6]
- New forms of commerce and financial intermediation[7]
- Mass customization of products[8]
- Reduction of excess inventories and optimization of supply chains[9]
- Business revenue growth[10]
- Growth in service industries[11]

Most of the research regarding the impact of broadband externalities on employment has been conducted using US data, although we have begun to develop studies for emerging countries.

Among the econometric studies of employment impact, are Gillett *et al.* (2006), Crandall *et al.* (2007), Shideler *et al.* (2007), Katz (2012) and Thompson and Garbacz (2008). Like the relationship between broadband and GDP growth, the contribution of broadband to employment is also conditioned by a number of special effects. Studies have particularly focused on two specific questions:

- Does the impact of broadband on employment differ according to industry sector?
- Is there a decreasing return in employment generation linked to broadband penetration?

As with GDP, the spillover employment effects of broadband are not uniform across sectors. According to Crandall *et al.* (2007), the job creation impact of broadband tends to be concentrated in service industries, (e.g., financial services, education, health care, etc.) although the authors also identified a positive effect in manufacturing. In another study, Shideler *et al.* (2007) found that, for the state of Kentucky, county employment was positively related to broadband adoption in the following sectors. The only sector where a negative relationship was found with the deployment of broadband (0.34% – 39.68%) was the accommodations and food services industry. This may result from a particularly strong capital/labor substitution process taking place, whereby productivity gains from broadband adoption yields reduced employment. Similarly, Thompson and Garbacz (2008) conclude that, for certain industries, "there may be a substitution effect between broadband and employment"[12]. It should therefore be considered

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5 See Atkinson *et al.*, 2009.

6 Op. cit.

7 Op. cit.

8 Op. cit.

9 Op. cit.

10 See Varian *et al.*, 2002; Gillett *et al.*, 2006.

11 See Crandall *et al.* (2007).

12 This effect was also mentioned by Gillett *et al.* (2006).

that the productivity impact of broadband can cause capital-labour substitution and may result in a net reduction in employment.

This effect has been analyzed by Katz et al. (2010) in the case of rural economies of the United States. In particular, it was found that, within rural counties, broadband penetration contributes to job creation in financial services, wholesale trade and health sectors. This is the result of enterprise relocation enabled by broadband, which benefits primarily urban communities in the periphery of metropolitan areas (Katz et al. 2010d). In fact, research is starting to pinpoint different employment effects by industry sector. Broadband may simultaneously cause labor creation triggered by innovation in services and a productivity effect in labor-intensive sectors. Nevertheless, we still lack a robust explanation of the precise effects by sector and the specific drivers in each case. However, given that the sectoral composition varies by regional economies, the deployment of broadband should not have a uniform impact across a national territory.

With regard to decreasing impact on employment, some researchers have found a decreasing impact of broadband on employment. While Gillett *et al.* (2006) observed that the magnitude of impact of broadband on employment increases over time, they also found that the positive impact of broadband on employment tends to diminish as penetration increases. This finding may support the existence of a saturation effect. Coincidentally, Shideler *et al.* (2007) also found a negative statistically significant relationship between broadband saturation and employment generation. This would indicate that at a certain point of broadband deployment, the capability of the technology to have a positive contribution to job creation starts to diminish.

In summary, a review of the research on the economic impact of broadband indicates multiple effects. Firstly and foremost, the evidence is fairly conclusive about the contribution of broadband to GDP growth. While the size of this contribution varies, discrepancies can be related to different datasets as well as model specifications. In addition, research has been successful in identifying the existence of a critical mass effect, indicating the existence of increasing economic returns of broadband penetration.

Secondly, broadband contributes to employment growth with spillover impacts on the rest of the economy. While deployment programs are, as expected, concentrated in the construction and telecommunications sectors, the impact of externalities are greater in sectors with high transaction costs (financial services, education, and health care).

3. The Panamanian Economy

Panama, a Central American country, depends heavily on its privileged geographical position. More than three quarters of its GDP derive from the well-developed services sector. The Panama Canal is scheduled to significantly expand and double its capacity by 2014, while a unique US dollar-based monetary regime has spurred growth in the banking and insurance sectors. The Colon Free Zone, the logistics industry, the flagship registry and tourism also contribute to the country's economic performance.

Economic growth is expected to be bolstered by the Panama Canal expansion project that began in 2007 and is scheduled to be completed by 2014 at a cost of US$ 5.3 billion - about 10% of current GDP. The expansion project will more than double the Canal's capacity, enabling it to accommodate ships that are too large to traverse the existing canal. The United States and China are the major countries of origin for the most frequent and heaviest users of the Canal. Panama

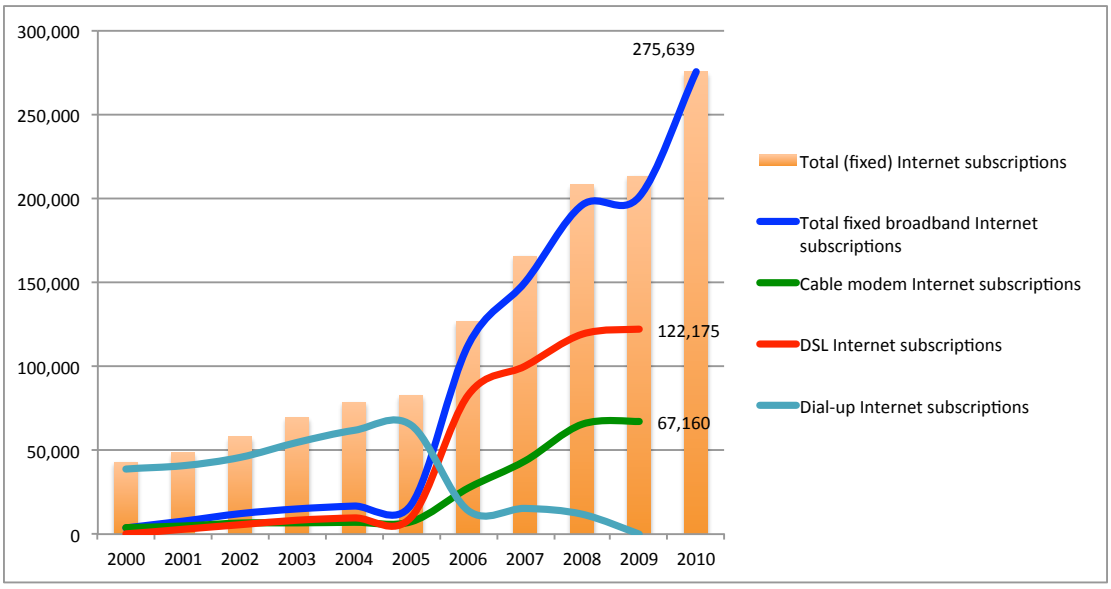
is upgrading its urban infrastructures, and has announced plans to construct a metro system in Panama City, valued at US$ 1.2 billion and scheduled to be completed by 2014. Panama's booming transportation and logistics services sectors, along with aggressive infrastructure development projects, have led the economy to continued growth in 2011.

Strong economic performance has not translated into broadly shared prosperity, however, and Panama has the second worst income distribution in Latin America. About 30% of the population lives in poverty in spite of a sudden drop by 10 percentage points from 2006 to 2010. Following a similar pattern unemployment dropped from 12% to less than 3% of the labour force in 2011. A US-Panama Trade Promotion Agreement was approved by the US Congress and signed into law in October 2011. Seeking removal from the Organisation of Economic Cooperation and Development's gray-list of tax havens, Panama has also recently signed various double taxation treaties with other nations.

4. The Telecommunications industry in Panama

The broadband communications sector has grown and transformed during the last ten years in Panama primarily bearing to the adoption of DSL access (Figure 3).

Figure 3: Fixed-line broadband connections (by technology) in Panama, 2000-2010



Source: ITU (2011), Wireless Intelligence (2012)

Until 2005, the majority of Internet connections were based on simple dial-up access, thus restricting users from high-speed access to advanced services. In 2006, both DSL and Cable connections surpassed PSTN access and initiated a major change in the Panamanian telecommunication market.

In 2009, DSL connections exceeded 122,000 lines and Cable 67,000[13]. Fixed broadband penetration reached 7.8% in 2010, making the country one of the most advanced in Central America[14].

Figure 4: Regional Broadband Adoption in 2010

Source: World Bank, 2012

In terms of the supply side, Cable & Wireless Panama (CWP) controls 90% of the fixed-line network (with some 393,000 subscribers), while the remaining part is shared among Cable Onda, Movistar, Claro Com, IFX, Sky Com, Tele Carrier, S1WC, System One and Advances 099. The annual revenue of the wireline sector was US$ 145.45 m in 2011.

The mobile sector in Panama is more competitive than the fixed, and accounts for more than three quarters of total national telecommunications revenue. In 2011, wireless sector revenues amounted to US$ 683 million, while the total telecommunications revenue accounted for US$ 892 million. Más Móvil (CWP) controls 54% of the mobile market (with 2,347,000 subscribers), while Movistar accounts for a little less than a third of mobile subscriptions. Digicel, having entered the market in 2008, now accounts for 16% of the mobile market, while the most recent entrant, Claro, has the remaining 0.7%.

[13] Source: ITU (2011)

[14] Excluding the Caribbean region

Table 2: Mobile Sector Market Share, June 2010

Company	Market Share
Más Móvil (CWP)	54%
Movistar	30%
Digicel	16%
Claro	0.7%

Source: Dichter & Neira Latin Research Network

The fixed broadband market is primarily shared among Cable and Wireless (70%) and Cable Onda (26%). Other competitors (WIPET and Advanced 099) control the remaining 4%.

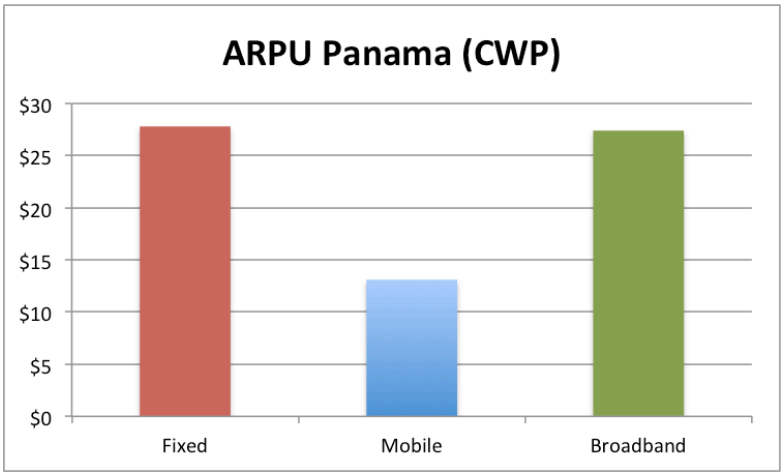
Table 3: Broadband Sector Market Share, June 2010

Company	Market Share
Cable & Wireless	70%
Cable Onda	26%
WIPET	2% (Approximately)
Advanced 099	2% (Approximately)

Source: Dichter & Neira Latin Research Network

In terms of average revenues per subscriber per month, broadband and fixed line access yield close to US$ 26, while the mobile equivalent is almost half this amount at US$ 13. Part of this difference is attributed to the competition of the mobile sector.

Figure 5: ARPU by access medium in Panama



Source: CW Panama

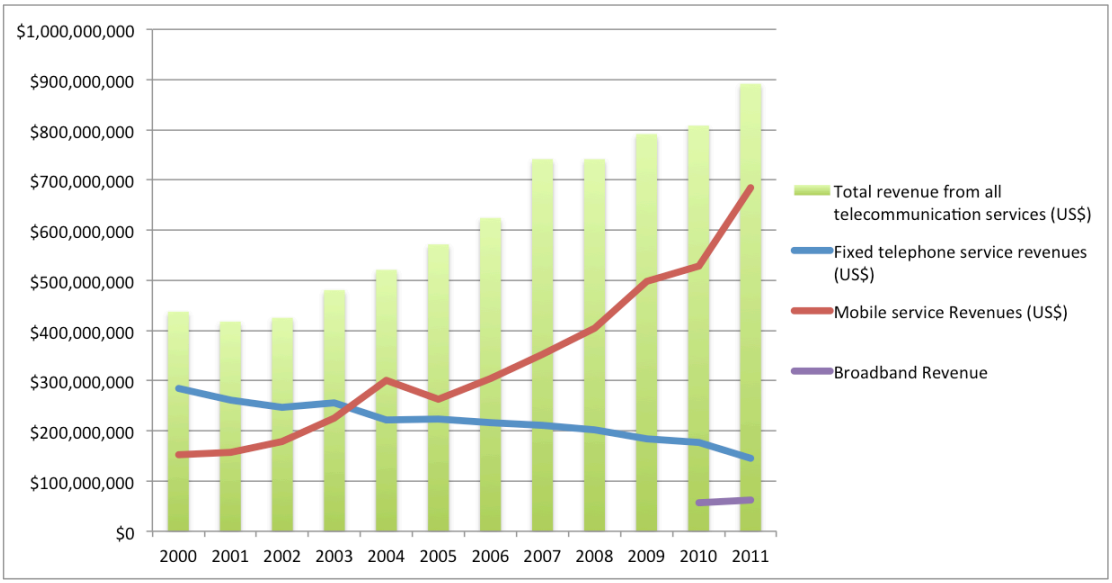
5. The economic impact of telecommunications and broadband in Panama

There are two distinct ways to assess the economic impact of telecommunications on the Panamanian economy. The first is the sector's direct impact, resulting from its significance and contribution to GDP (Figure 6), as well as the employment being generated by its operators and their local suppliers. Additionally, the sector also contributes to the economy by means of taxes, such as corporate levies, value-added tax, and other fees. Besides, broadband communications as a general purpose technology, have an impact resulting from the network effects and spillovers to other productive sectors as was reviewed in Section 2. This Section assesses the direct and indirect contribution that telecommunications has made so far to economic development in Panama.

5.1 Direct economic contribution of telecommunications

The contribution of the telecommunication sector in the Panamanian economy has been growing along with national GDP, thus remaining at an almost stable level around 3.0% in 2011. In terms of tax contribution, the sector suffered a significant increase in direct taxation after 2008, as an additional tax was imposed, raising the total tax level from 5% to 12%[15]. In 2011, the total tax contribution of the telecommunications sector accounted for 3.7% of all tax collection in the country, reaching US$ 107.1m. The mobile sector contributed US$ 82.06 m, fixed line access US$ 17.45 m and broadband US$ 7.50 m.

Figure 6: Percentage of GDP

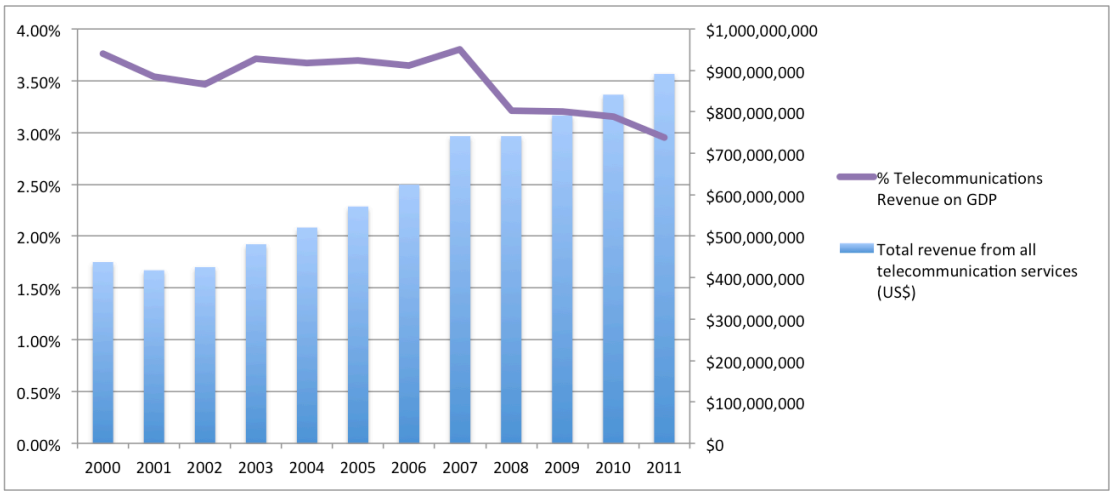


Sources: ITU and CW Panama (2010)

[15] After 2008, a new tax was introduced in addition to the existing 5%. The new tax of 7% is imposed along the "Impuesto sobre las Transferencias de Bienes Muebles y Servicios" (ITBMS).

The total revenues of the Panamanian telecommunications industry represented US$ 892 m (or 3.0% of the national GDP) in 2011. This ratio has been largely constant since 2002, with an increasing part of the revenues attributed to the mobile sector (Figure 7).

Figure 7: Telecommunications revenue and % of telecommunications revenue on GDP in Panama



Sources: ITU, World Bank

In parallel to its direct economic contribution, the telecommunication industry has an important impact in the creation of direct jobs (i.e. telecommunication employment). The total number of direct jobs in telecommunications reached 15,929, representing 1.21% of total employment in the country.

5.2 Indirect economic contribution of broadband

As shown in the literature reviewed above, beyond the direct economic contribution, telecommunications can have a positive contribution to economic growth. This section assesses the positive externalities of telecommunications on the economy of Panama. As anticipated in the introduction, given the different penetration rates exhibited by mobile telephony and broadband, the analysis of economic impact of both technologies is conducted through a structural econometric model.

Regional and country-level statistical studies of ICT impact in emerging economies usually suffer from a lack of microdata as the institutions and technical committees do not always collect information in a frequent and consistent manner. More information on data for Panama, as well

as the specific resources utilized in the study, can be found in the Appendix.[16]

The model comprises four equations: an aggregate production function modelling the operation of the economy and three distinct demand, supply and output functions. The last three functions model the mobile market operation and, controlling for their reverse effects, the actual impact of the infrastructures is estimated. In the production function, GDP is linked to the fixed stock of capital, excluding ICT infrastructure and labour and broadband infrastructure, which is proxied by fixed broadband penetration.

The demand function links broadband penetration to the average consumption propensity of individuals proxied by GDP per capita and the cost of a basic broadband service. Subscribers are largely dependent on the entry-level prices of technology services that often attract the majority of the operators' target audience. The supply function links aggregate broadband revenue to the corresponding price levels the GDP per capita and the degree of urbanization in the country. As fixed broadband services benefit from higher population concentration, the migration to urban areas may affect the supply of such services. Both parameters have an impact on potential and existing operators as well as the dynamics of the supply side of the market. The infrastructure equation links annual change in broadband penetration to broadband revenues, used as a proxy of the capital invested in a country during one year[17].

The econometric specification of the model is included in the appendix together with the analysis of the results.

Based on these models, broadband infrastructure was found to have significantly affected the Panamanian economy over the last 10 years between 2000-2010 (see table 5 in the appendix). This finding is key, given the small fraction of the population that initially adopted the technology. In practice, only one percent of the population used fixed broadband connections in 2005, although this proportion might be underestimated as these connections are ususally shared among the members of each household. The interpretation of this outcome requires a better understanding of the location specific parameters. In terms of actual growth contribution of the technology[18], we estimated again the compound annual growth rate.[19]

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[16] This situation introduces a degree of complexity in the data mining phase. Data for this analysis come from the ITU, Wireless Intelligence and the regional operators (Cable & Wireless). Adoption metrics (fixed line, ADSL, Cable) have been fairly consistent since the fourth quarter of 2000 until 2010. The costs for telecommunication services are provided by the operators. Other macroeconomic metrics (GDP, fixed capital formation, education, labor force, etc) are available from the corresponding sector ministries. Market performance metrics (capex, revenues etc) are also available from local operators.

[17] This assumes a stable and constant link between income and investment, which in some cases might not be the case. Unfortunately, fixed gross capital formation for telecoms, which would be the more appropriate variable, was not available.

[18] We follow the analysis in Koutroumpis (2009).

[19] We estimate the CAGR for Panama using formula (15):

$$CAGR = \left[\left(\frac{\frac{Pen_{2010}}{100-Pen_{2010}} - \frac{Pen_{2000}}{100-Pen_{2000}}}{\frac{Pen_{2010}}{100-Pen_{2010}}}\right) * \hat{a}_3 + 1\right]^{1/10} \qquad (15)$$

The annual contribution to Panama's GDP from fixed broadband lines is approximately 0.44% of GDP as a compound average annual growth rate for 2000-2010[20]. **This translates into annualized average contribution to the Gross Domestic Product equal to 0.44% growth of GDP**. Given that the economy grew – on average – at 4.6% during this period, this estimate suggests that fixed broadband lines alone were responsible for 9.6% of all economic growth in Panama during the past decade. It is worth emphasizing that the actual impact of broadband can be traced after 2005. Reshaping formula (15) to match this change, we find that **for the period 2005-2010, the contribution of fixed broadband rose to 0.82%, almost doubling the average figure for the decade**. Since the economy grew much faster during this period (at approximately at 7.2%), this means that approximately 11.3% of all economic growth was due to fixed broadband connections in Panama.

Besides, the structural model provides estimates for other important parameters of the economy. Again, fixed capital formation is a strong catalyst of GDP growth, suggesting an important contribution to the economy. Similarly, labor force critically affects the Panamanian economy. It is suggested that 1% more skilled labor would increase the country's GDP by 1.15%. This can be attributed both to a limited expansion of infrastructures and the large dependency on quality of the labour force.

In terms of demand of broadband services, subscription prices are key enablers for adoption of the technology. Strikingly, a 10% drop in prices will boost adoption by more than 21%.[21] Income variation across the sample period seems to have a similar impact on this process. Hence increasing the average disposable income by 1% yields 2.4% greater adoption in fixed broadband lines. The estimated figures suggest that the Panamanian population could adopt fixed broadband at a rate more than twice their annual GDP growth. Essentially this translates into the increasing importance of the infrastructure and the subsequent service provided over this.

Supply dynamics suggest that income levels affect the revenues and investments of operators. The consumption propensity for broadband services seems to have a siginificant impact on increasing the supply of digital offerings. Increasing the disposable income (as proxied by change in GDP) attracts 0.56% more supply (based on the coefficient of change of GDP in the supply equation in Table 8). Urbanization is found to have a positive effect on service supply, hinting that fixed broadband operators are sensitive to the demographic characteristics of their target areas. Just 1% higher urbanization across the country would lead to an increase of 0.37% in the supply of services. Usually urban areas have densities five or ten times higher than rural segments. This in turn implies that fixed broadband supply might range substantially, both within the country and across time.

Finally, revenues are found to have a significant impact on the performance of the industry, implying a reinvestment of the output to the productive basis of the economy[22]. This is an additional angle supporting increasing returns to scale of ICT infrastructure.

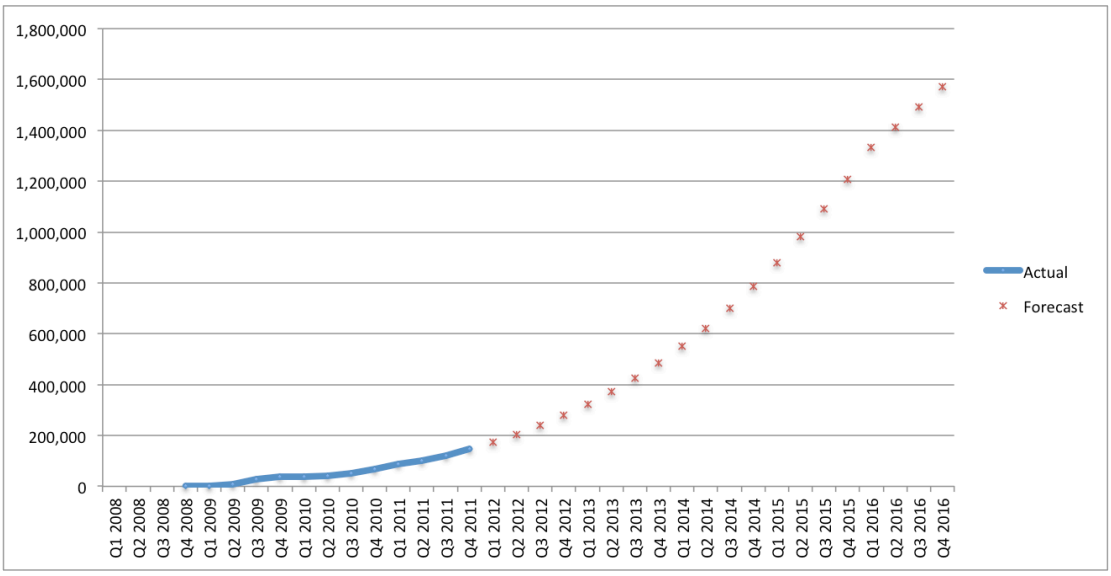
[20] This result stems from almost zero penetration in 2000

[21] based on the coefficient of fixed broadband prices in the demand equation in table 12 (-2.121).

[22] This is particularly relevant for markets undergoing high growth, while it not be the case with saturated markets.

The future of broadband in Panama is not linked solely to fixed access. Frequently, countries with limited fixed access networks experience displacement (rather than substitution) towards rapid adoption of mobile broadband services. Current adoption of mobile broadband can be split into mobile phones with access to the Internet and dedicated mobile broadband services. The former represent almost 4.2% of per capita (Q4 2011)[23] penetration, while the latter less than 0.05%. This limited use of dedicated mobile broadband access is the reason for not exploring further its impact on economic growth of the country. Additionally, measurable mobile broadband access started to evolve right after the beginning of 2009. Mobile broadband connections are forecast to be used by 45.4% of the Panamanian population by 2016[24]. Given the significant impact of fixed broadband, it is expected that mobile broadband will also contribute to the growth of the economy. Additionally, the mobility attributes of 3G and LTE connections can help serve the rural and remote parts of the country reducing social exclusion, increasing digital literacy and connecting those areas to the rest of the world.

Figure 8: 3G and HSPA forecast in Panama



Source: Wireless Intelligence

6. Conclusions

Fixed broadband has a significant economic impact in Panama. The Central American country with an average of $13,600 in purchasing power[25] per capita has drawn much of its growth

[23] Source: Wireless Intelligence (2012)

[24] Source: Wireless Intelligence (2012)

[25] CIA Factbook, 2011

through an open and service-based economy. During 2000-2010[26], **fixed broadband contributed an average of 0.44% to GDP every year**. This translates into 9.6% of all growth in the country given the average rate of 4.6% at the same period. Furthermore, since 2005, this impact has almost doubled, **reaching 0.82% of GDP** and representing 11.3% of all economic growth.

The policy implications of the results of this case study are self-evident. The private telecommunications sector has been able to match the rising needs of households and businesses and help the country become a leader, among its close counterparts. Future challenges for Panama include applying the lessons learned from wireless voice services and fixed broadband, and leveraging the telecommunication industry structure to accelerate mobile broadband adoption. Wireless broadband represents an appropriate technological platform to meet this challenge. Its deployment will favour/facilitate the development of domestic and export-oriented economic activity. In parallel, the development of applications in education, public health, media and entertainment, and government services, will act as incentives to broadband adoption.

[26] Panama fixed penetration was 8% at 2010

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APPENDIX

Data sources for the Panama analysis:

Table 4: Data and sources for Panama

Variable	Explanation	Source
GDP	Gross Domestic Product in constant USD (2000)	World Bank
GDPC	Gross Domestic Product per capita in constant USD (2000)	World Bank
K	Gross fixed capital formation in constant USD (2000)	World Bank
L	Labor force with secondary education	World Bank
BB_Pen	Fixed broadband penetration (in 100 people)	World Bank
BBPr	Fixed broadband price per month	Local Operators (CW Panama)
BB_Rev	Fixed Broadband Telecommunications revenue	ITU
Urb	Urbanization	World Bank

Structural model for the impact of fixed broadband on the Panamanian economy:

Aggregate Production function:

$$GDP_{it} = a_1 K_{it} + a_2 L_{it} + a_3 BB\_Pen_{it} + \varepsilon_{1it} \quad (11)$$

Demand function:

$$BB\_Pen_{it} = b_1 BBPr_{it} + b_2 GDPC_{it} + \varepsilon_{2it} \quad (12)$$

Supply function:

$$BB\_Rev_{it} = c_1 GDPC_{it} + c_2 Urb_{it} + \varepsilon_{3it} \quad (13)$$

Output function:

$$\Delta BB\_Pen_{it} = d_1 BB\_Rev_{it} + \varepsilon_{4it} \quad (14)$$

Results for the impact of fixed broadband on the Panamanian economy:

Table 5: Results of Broadband Infrastructure Model

Variables	**Fixed Broadband Model**
Growth (GDP_{it})	
Labour force (L_{it})	1.148***
Fixed Capital Stock (K_{it})	0.234***
BB Penetration (BB_Pen_{it})	0.045***
Constant	-
Demand (BB_Pen_{it})	
BB. Price ($BBPr_{it}$)	-2.121***
GDPC ($GDPC_{it}$)	2.443***
Constant	-18.536**
Supply (Mob_Rev_{it})	
GDPC ($GDPC_{it}$)	0.556***
Urbanization (Urb_{it})	0.374***
Constant	13.910***
Output (ΔBB_Pen_{it})	
BB Revenue (BB_Rev_{it})	4.606***
Constant	-95.451***
Year Effects	YES
Obs	40
R^2	(1)
Growth	0.99
Demand	0.92
Supply	0.97
Output	0.40