Inter-American Development Bank

Telecommunication Sector Policies for the Development of Information and Communication Technologies in Panama

Part II

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Country Department for Central America, Haiti, Mexico, and the Dominican Republic

TECHNICAL NOTE Nº IDB-TN-1466

August 2018

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IDB
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Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library
De Lira Salvatierra, Irving Arturo.
Telecommunication sector policies for the development of information and communication technologies in Panama: part II / Irving Arturo De Lira Salvatierra.
p. cm. — (IDB Technical Note ; 1466)
Includes bibliographic references.
1. Telecommunication policy-Panama. 2. Information technology-Government policy-Panama. 3. Internet in public administration-Panama. 4. Big data-Panama. 5. Internet of things-Panama. I. Inter-American Development Bank. Country Department Central America, Haiti, Mexico, Panama and the Dominican Republic. II. Title. III. Series.
IDB-TN-1466

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JEL Codes: L16, L20, L40, L86, L96

Keywords: Telecommunications, information technologies, economic valuation, public policy

Contents

Executive Summary

For the past decades, citizens, governments, and companies from all around the world have experienced the so-called "fourth industrial revolution," in which connectivity and Internet access were (and still are) the key enablers of modern technologies. Nonetheless, this fast transformation is converging, for the first time in the history of humanity, to the fifth industrial revolution, or 5.0 revolution, in which connectivity and Internet access are taken for granted, and data, automation, and digitalization will become the key enablers to adopt new platforms and technologies.

In this sense, Information and Communication Technologies (ICTs) are increasingly becoming the central foundational stone of progress. Its immersion to society, business and governments are fundamental to increase productivity, growth, and social welfare. Consequently, public policies and regulation in the telecommunications sector and digital applications play a central role.

The actions that governments can take to boost the development of telecommunications and in the promotion of ICTs immersion can be divided into four objectives: infrastructure deployment and investment, flexible regulation to promote competition and allocation of essential inputs, digital alphabetization through e-applications and digital agendas, and finally, a prospective assessment of new businesses, technologies, and platforms that will reshape the competitive environment of the telecommunications sector.

The first two objectives can be seen as the structure of a building, are the foundations of the 5.0 revolution. Its impact is directly related to more broadband - fixed and mobile – penetration and internet access, at affordable prices with services of high quality. Without access, that is taken for granted; any other policy will only be a waste of resources with null or almost zero impact.

The third objective is related to the efficient and productive use of digital platforms and ICTs. Connectivity is not enough; it should be used for productive purposes and also for the development of new tools that increase the quality of life. In this case, programs that incentivize innovation, alphabetize people in digital platforms and target segments of the population according to sociodemographic aspects must be implemented. These programs should also be continuously assessed since in the data era the only thing that remains constant is the continuous evolution of technologies and digital applications.

The last objective is closely related to the last point mentioned above, continuous evolution of technologies. Authorities in charge of the development of telecommunications and ICTs adoption should be aware of the latest advances all around the world and should issue flexible rules that do not prevent the creation process and immersion of new products. For example, 5.0 era will face challenges regarding artificial intelligence, cyber-security, protection of personal information, Big Data regulation, and other applications that we do not know yet, but that at this very moment are being developed.

Thus, this document is the first of a two-volume study that provides a policy guideline that draws conclusions from international experience and economic analysis to recommend some policies that are expected to foster the development of ICTs in Panama, as well as to provide insights and guidelines of

the most recent developments in regulation for new technologies and platforms, such as cybersecurity and Internet of Things (IoT), among others.

This volume contains three chapters. The first chapter provides a comparative assessment of the regulations in the telecommunications sector and establishes a clear map of the private and public-sector agents in Panama to assess the political economy in the sector development. This chapter also identifies the regulatory and market environment deficiencies in Panama, including the mapping of relevant agents in the sector. The second chapter presents a detailed map to improve the regulatory environment to bolster the sector and close the identified gaps. The same chapter describes a strategic action plan to assess the range of available policies that could contribute to close the gaps. The third chapter links both volumes with the overall findings and conclusions and establishes an outlook of telecommunications and ICTs in Panama for the next years, is a long-term analysis.

Regulatory Framework Analysis

This first part of the document aims to provide a detailed map of the private and public sector agents in Panama´s telecommunication sector to assess the political economy in the sector development. In this sense, the chapter provides a comprehensive review of the key players, public and private, and current legal framework under different edges, such as key inputs in the sector - spectrum and infrastructure - , investment and mergers and acquisitions, access and quality, competition and consumer´s protection regulation, and new regulation – digital agendas and 5.0 rules -.

The objective is to identify the potential deficiencies that could be preventing Panama´s telecommunications sector from growing at similar rates to those observed in advanced countries and other similar countries.

Comparative Assessment

This subsection provides a detailed description of the major public and private agents in Panama´s telecommunications sector and other comparable countries, such as Chile, Colombia, Costa Rica, Ecuador, Mexico and Spain. Those countries were chosen using the criteria in Volume 1 (Appendix A: K-nearest neighbor classification algorithm details).

Also includes an analysis of the current regulatory environment to assess its effectiveness to develop the sector, particularly the growth, inclusion and impact of Telecommunication and Information Technology (ICT) in society and industries.

The evaluation of the current regulatory environment and its comparison with other success cases will be helpful to identify the bottlenecks that inhibit ICTs full penetration in Panama´s key economic sectors and society.

Before starting with the comparative assessment, it is important to describe the overall trends in Panama, not only in the telecommunications sector but also at the aggregate level. In this regard, over the last years, Panama has been one of the most growing economies in America. Its Gross Domestic Product (GDP) per Capita measured on constant PPP international dollars has passed from $ 10.69 in 2003 to $ 21.3 in 2016, a growth of almost 100% in 13 years.[1] The remarkable income growth of the economy boosts employment, investment, consumption and reduces poverty across the country. In 2011 Panama reached a maximum real GDP growth rate of 11.8%, and a minimum unemployment rate of 4.2 %, however since 2011 GDP growth gets deaccelerated, and unemployment started to rise. The main reason behind the end of the miracle is a decline in construction mainly by the end of the expansion of the Panama Canal (IMF, 2017).

The years of accelerated growth rate and the oncoming trend of exploit services exports (mainly financial services) has exacerbated telecommunications importance in the country. ICT accounted for 8% (or $4,415 million) of Panama's GDP in 2016 and generated 3.7% of total tax collection. Besides, the telecommunication and information sector accounted for 1.4% (24,753 direct jobs) of 2017 total

[1] World Bank data.

employment. Regarding the impact on the population, internet users have growth 36% between 2010 and 2015, and mobile phone penetration on 2016 was 169 per 100 habitats, one of the highest in Latin America.[2]

Regarding Panama's sector composition, Cable & Wireless Panama and Cable Onda gathers 94% of fixed broadband subscriptions, and in the mobile phone sector Cable & Wireless Panama, Digicel Panama and Movistar Panama gathers 96% of cellular subscriptions.[3] To increase coverage and quality, it is necessary to foster competition on both the mobile and the fixed markets. Some competitive mechanism like MVNOs (mobile virtual network operator) or infrastructure sharing practices are examples of regulatory updates that could improve Panamas telecommunications market.

Given the above description of Panama´s telecommunications sector, the next subsection starts with the comparative assessment of the current regulation in the country and how it compares regarding other countries.

Regulatory authorities

Panama

The National Public Services Authority *(Autoridad Nacional de los Servicios Públicos or ASEP)* is an autonomous state agency, managing its funds separately from the Central Government, possessing its patrimony.[4]

The head of the ASEP is the General Administrator, who is appointed by the Executive and ratified by the Legislative Branch for a seven-year term, and three directors that verify and supervise the following sectors: energy, waterworks and sewage, user relations, and telecommunications.

The decisions issued by the National Directors are subject to appeals, which are resolved by the General Administrator. First instance decisions issued by the General Administrator are revised by the same General Administrator through a writ of reconsideration. The final decision of the General Administrator may be contested before the Supreme Court of Justice, Third Chamber on Administrative Matters.

ASEP, through the National Telecommunications Directorate, has the purpose of effectively regulating, ordering and supervising, among others, the operation and administration of telecommunication services, radio and television services, as well as radio spectrum. The regulatory enforcement is achieved by the resolutions that the ASEP dictates following the legal provisions that regulate the matter.

The Consumer Protection and Competition Defense Authority *(Autoridad de Protección al Consumidor y Defensa de la Competencia or ACODECO)* is the public institution entitled to perform investigations on anti-competitive practices, and apply sanctions.[5] Although, the ASEP has the power to issue resolutions

[2] Data for ICT contribution to GDP from Panama digital Agenda 4.0, for tax collection from Katz (2012), for direct jobs from INEC, for internet usage and mobile phone penetration from ASEP.
[3] Data from OVUM.
[4] http://www.asep.gob.pa/
[5] http://www.acodeco.gob.pa/

and rules to promote fair and efficient competition, as well as to prevent anti-competitive practices in the provision of services. Under the current legal framework, ASEP and ACODECO have a joint jurisdiction, in the sense that the competition authority is entitled to make the final decision concerning monopolistic, and anticompetitive or discriminatory practices, while the telecommunications regulator assists ACODECO in the investigations, recommends precautionary measures and denounces possible anti-competitive practices.

In addition to ASEP and ACODECO, the National Authority for Government Innovation *(la Autoridad Nacional para la Innovación Gubernamental or AIG)*, established by Law 65 on October 30, 2009, has the authority to plan, coordinate, issue guidelines, supervise, collaborate, support and promote the optimal use of ICTs in the government for the modernization of public management. AIG is also in charge of the adoption of national policies, plans, and strategic actions.[6]

Chile

In Chile, Decree 1762 created Ministry of Transport and Telecommunications the central entity that leads, guides, controls and fosters the development of telecommunications in the country.[7] The Ministry of transport and telecommunications designs national policies on transportation and telecommunications in line with the aims of the central government and supervises the operation of public and private companies of the sector. The ministry is integrated by the Sub-secretary of transport, the Sub-secretary of telecommunications (SUBTEL) and Civil Aeronautics. SUBTEL was created by Decree 1762 of 1977; its primary responsibilities involve design programs and methods to reduce the digital gap, protect telecommunications' user´s rights, increase the quality of services provided in the sector, foster competition, and promote ICT infrastructure for digital and Aerospatiale development. [8]

Lastly, the council of ministers for spatial development and the Competition tribunal are two organisms that contribute to ICT sector. [9] The first supports the Executive Branch in the elaboration of public policies, plans and programs, and specific actions that contribute to the promotion of apps and spatial technologies; the second has the purpose of preventing, amend and punish attempts to limit free competition; his actions are implemented in coordination with SUBTEL, who also promotes free competition regulation in the sector.

Colombia

The Ministry of information technologies and communications is the central institution of ICTs in Colombia; according to Law 1341 of 2009, the ministry is in charge of designing, adopting and promoting policies, programs, and projects for the ICT sector. Its primary functions are increasing and facilitating ICT universal access to improve life quality of all the population through effective policies that foster ICT development, like human capital oriented policies or incentives to infrastructure deployment. Also, the

[6] http://www.innovacion.gob.pa/
[7] www.mtt.gob.cl
[8] www.subtel.gob.cl
[9] www.tdlc.cl

ministry is in charge of defining the strategy, planning, and administration of the radio-electric spectrum and postal services. [10]

The leading regulation authorities in Colombia are *Comisión de Regulación de Telecomunicaciones* (CRC), and *Superintendencia de Industria y Comercio* (SIC). [11] The former is an entity in charge of promotion of free competition, fighting against market abuse and designing an appropriate regulation for the telecommunication sector, the latter regulates and supervises all industries in favor of consumers' welfare and free competition. [12] Furthermore, Law 1341 creates *Agencia Nacional del Espectro* (ANE) an agency in charge of conducting and planning national radio spectrum and giving technical support to regulatory decisions. [13]

Costa Rica

The Ministry of science, technology, and telecommunications (MICITT) is the institution that promotes the development of sciences, technologies, innovation, and telecommunications.[14] It designs national policies for the use and development of telecommunications and coordinates the national development plan for telecommunications. It receives resources from the national budget. A Minister and two deputy Ministers of Science and Technology, and Telecommunications head the Ministry, which are appointed by the President of Costa Rica.

Costa Rica's main regulatory authority is ARESEP (Regulation Authority of Public Services), who has the objective to promote competition in all industries. However, in the particular case of the telecommunications sector, the Superintendence of Telecommunications (SUTEL) is the specialized regulatory body in charge of the sector´s regulation and is ascribed to ARESEP.[15]

SUTEL issues rules regarding prices, tariffs, and quality of telecommunication services; it is the sectorial authority of competition, the counsel of user rights, the regulator of radio spectrum and the administrator of the National Fund of Telecommunications (FONATEL). The functions of SUTEL include setting maximum prices, promoting competition, approving operators, promoting interconnection between companies, among others. As mentioned above, SUTEL is the administrator of FONATEL, which provides free internet access and telephone services to medical centers, community centers, public schools and isolated villages.

Ecuador

The Ministry of Telecommunications and Information Society is the governing body of ICTs in Ecuador; it issues ICT policies, plans, programs, and monitors the corresponding implementation of them. It also coordinates actions with strategic players of the sector, to guarantee equal universal access and broader

[10] www.mintic.gov.co
[11] www.crcom.gov.co
[12] www.sic.gov.co
[13] www.ane.gov.co
[14] https://www.micit.go.cr
[15] http://sutel.go.cr/

ICT usage. The ministry designs the digital agenda of the country, which contains sectoral and inter-sectoral guidelines that Ecuador must follow in coming years, to reach more digital inclusion and highest competitiveness. [16]

The Organic Law of telecommunications of 2015 created Ecuador's regulation authority ARCOTEL. The law aims to regulate radio-electric spectrum usage and telecommunication services with the purpose of guarantee universal access, quality of services, and telecommunication's affordability. Furthermore, the law defines guidelines to manage scarce resources inherent to the telecommunication sector through efficient, fair and environmental sustainable allocations; finally, it assurances the main principles of ICT services, such as supply, accessibility, continuity, universality, security, and privacy protection. [17]

Mexico

The Ministry of Communications and Transportation *(Secretaría de Comunicaciones y Transportes or SCT)* is a federal entity in charge of policy formulation in the telecommunications and broadcasting sectors.[18]

After the 2013 Mexican Reform in Telecommunications, the Federal Telecommunications Institute (*Instituto Federal de Telecomunicaciones or IFT*) was created as an autonomous body, for functional and budgetary purposes, endowed with ample powers to enforce the Law and the regulations related to the telecommunications and broadcasting sectors.[19] It is also the competition authority in these sectors. The Federal Economic Competition Commission (COFECE) is a fully autonomous competition agency with extensive enforcement powers in several sectors, except telecommunications and broadcasting, although it issues opinions to the IFT in some cases of concentrations and mergers and acquisitions (M&A).[20] Other authorities and entities who participate in both sectors are the Mexican Ministry of Finance and Public Credit and the Federal Attorney's Office of Consumer (PROFECO).[21]

Spain

The Ministry of Energy, Tourism and Digital Agenda (MINETAD) is in charge of the development and execution of the government policy on energy, tourism, telecommunications and information society.[22] It also designs the Digital Agenda and is headed by a Minister and three secretaries of state: Secretary of Energy, Secretary of Information Society and Digital Agenda and Secretary of Tourism. The President of Spain appoints these primary positions.

The National Commission on Markets and Competition (CNMC) is the authority on competition since 2013, and it is the result of merging former regulatory entities (Energy, Telecommunications market,

[16] www.telecomunicaciones.gob.ec
[17] www.arcotel.gob.ec
[18] https://www.gob.mx/sct
[19] http://www.ift.org.mx/
[20] https://www.cofece.mx/
[21] https://www.gob.mx/hacienda and https://www.gob.mx/profeco
[22] http://www.minetad.gob.es

Postal Sector, Audiovisual media and Railway and airport regulation).[23] Its primary objective is to promote competition and proper function of all markets. The CNMC has as primary features to apply competition regulations, encourage competition, market unity, settle conflicts between operators and supervise all markets. It has autonomous legal status, independent from the central government but subject to parliamentary control

In the telecommunications sector, the CNMC functioning is based on the regulation of the European Union.[24] In particular, the commission functions in the telecommunications sector include: the definition of the competition level, imposition of obligations to operators with significant market power, determination of the contribution of operators to the National Fund for Universal Services, resolution of disputes among operators, definition of portability specifications, and supervision of compliance of regulations in the sector.

[23] https://www.cnmc.es/
[24] https://ec.europa.eu/digital-single-market/en

Table 1: Regulatory Authorities

Regulatory authorities

Country	Ministry of Telecommunications	Regulation Communications authority	Competition Authority	Broadcasting authority	Consumer protection
Chile	Ministry of Transports and Telecommunications (Ministerio de Transportes y Telecomunicaciones,MTT)	Subsecretary of Telecommunications(Subsecretaria de Telecomunicaciones, SUBTEL)	Free competition Court (Tribunal de Defensa de Libre Competencia ,TDLC)	TV National Council (Consejo Nacional de Televisión ,CNTV)	National Customer Service. (Servicio Nacional del Consumidor ,SERNAC)
Colombia	Ministry of Telecommunications and Information Technologies (Ministerio de Tecnologías de la Información y las Comunicaciones ,MINTIC)	Comission of Telecommunication's Regulation (Comisión de Regulación de Telecomunicaciones ,CRC),	Superintentdence of Industry and Commerce (Superintendencia de industria y comercio ,SIC)	TV National Authority (Autoridad Nacional de Televisión ,ANTV)	Superintentdence of Industry and Commerce (Superintendencia de industria y comercio ,SIC)
Costa Rica	Ministry of science, technology and telecommunications (Ministerio de Ciencia, Tecnologia y Telecomunicaciones, MICITT)	Superintendence of Telecommunications (Superintencia de Telecomunicaciones, SUTEL)	Commission to promote competition (Comision para Promover la Competencia, COPROCOM) and Superintendence of Telecommunications (SUTEL)	Ministry of science, technology and telecommunications (MICITT)	National Commission of Consumer (Comision Nacional del Consumidor, CNC)
Ecuador	Ministry of Telecommunications and Information Society (Ministro de Teleocmunicaciones y de la Sociedad de la Informacion)	Agency of Telecommunications Regulation and Control (Agencia de Regulacion y Control de las Telecomunicaciones, Arcotel)	Agency of Telecommunications Regulation and Control (Agencia de Regulacion y Control de las Telecomunicaciones, Arcotel)	Agency of Telecommunications Regulation and Control	Ministry of Industry and Productivity (Ministerio de Industrias y Productividad, MIP)
Mexico	Ministry of Communications and Transportation (Secretaria de Comunicaciones y Transportes, SCT)	Federal Telecommunications Institute (Instituto Federal de Telecomunicaciones, IFT)	Federal Commission of Economic Competition (Comision Federal de Competencia Economica, COFECE) and Federal Telecommunications Institute (IFT)	Ministry of Interior (Secretaria de Gobernacion, SEGOB) and Federal Telecommunications Institute (IFT)	Federal Attorney's Office of the Consumer (Procudaria Federal del Consumidor, PROFECO) and Federal Telecommunications Institute (IFT)
Panama	National Authority of Government Innovation (Autoridad Nacional para la Inovacion Gubernamental, AIG)	National Public Services Authority (Autoridad Nacional para los Servicios Publicos, ASEP)	Consumer Protection and Competition Defense Authority (Autoridad de Proteccion al Consumidor y de Defensa de la Competencia, ACODECO)	National Public Services Authority (ASEP)	Consumer Protection and Competition Defense Authority (ACODECO)
Spain	Ministry of Energy, Tourism and Digital Agenda (Ministerio de Energia, Turismo y Agenda Digital, MINETAD)	Ministry of Energy, Tourism and Digital Agenda (MINETAD)	National Commission on Markets and Competition (Comision Nacional de los Mercados y la Competencia, CNMC)	Ministry of Energy, Tourism and Digital Agenda	Telecommunications User Service Office (Oficina de Atención al Usuario de Telecomunicaciones, OAUT)

Source: Broadband Policies for Latin American and the Caribbean, a digital economy toolkit, OECD. Spain: Ministry of Energy, Tourism, and Digital Agenda.

General Regulation framework (Constitution, laws, and other guidelines)

Panama[25]

Telecommunications in the Republic of Panama constitute a public service, and as such, are regulated by Law No. 31 of February 8, 1996[26], which has the fundamental objective of accelerating the modernization and development of the sector, promoting the Private investment in the market, extend their access, improve the quality of the services provided, promote low user fees and fair competition in the provision of telecommunications services.

According to the current law, telecommunications include any transmission, emission or reception of signs, signals, writings, images, sounds or information of any nature, through physical lines, radio transmissions, and optical media or any other existing transmission system or means in the future.

Similarly, the public services of Radio and Television are regulated by Law No. 24 of June 30, 1999, which establishes the legal and technical basis for the operation of these services and additionally indicates the functions that the ASEP has as the regulatory body in this matter.

In addition to Law No. 31, Panama has other laws that establish the general framework for the operation and development of the telecommunications sector. The main laws are:

- Law No. 6 of January 21, 2004, which creates an ad valorem of twelve percent on the value of any international long-distance call for public use billed in Panama.
- Law No.54 of October 25, 2001, which creates a tax for telephone calls abroad.
- Law No. 5 of February 9, 1995, by which the National Telecommunications Institute is restructured.
- Law No. 17 of July 9, 1991, by which Articles 8, 10 and 11 of Law No. 14 of July 29, 1987, Article 2 of Law No. 38 are amended, and dispositions are dictated on the cellular telephony.

Panama's regulation also considers sectoral plans, which details how the service systems or networks of each sector should operate and develop. In the telecommunications sector, the Regulatory Body (ASEP) is responsible for developing, through specialized consultants, studies of the sectoral plans that establish the guidelines and rules on which the different services provided in this sector should be based. The service providers are obliged to carry out the implementation of the systems and networks, considering the guidelines and norms established in the sectoral plans.

The different sectoral development plans that regulate the operation of telecommunications systems are required so that all telecommunications systems can work in a compatible way and communicate with each other, so that the information of video, data, voice and any other signal, can be transmitted reliably and safely among the different service networks that are offered in this sector. For this purpose, the ASEP approved, through Resolution No. JD-106 of September 30, 1997, the National Telecommunications Technical Plan, which includes the following fundamental plans:

[25] The information concerning Panama in this chapter is based on public information published by ASEP (http://www.asep.gob.pa/).
[26] Law No.31 was amended in June 30, 1999.

- **National Frequency Allocation Plan**, which is the main tool that includes the legal and regulatory elements for the national administration of frequencies.
- **National Telephone Numbering Plan**, which is a system for managing telephone number resources in each country. This plan has the objective to use the minimum possible number of digits for telephone numbers, but as subscribers increase it is inevitable to increase the numbers of the telephone numbers or divide the numbering areas, to increase the availability of telephone numbers. Therefore, the plan must provide sufficient digits capacity and consider the evolution of long-term telecommunications systems.
- **National Routing Plan**, includes the guidelines to establish communications from the local telephone exchange to the arrival point in the fastest and most economical way possible.
- **National Synchronism Plan**, has the purpose of facilitating the global understanding of the most fundamental elements of the synchronization of telecommunications systems and guiding Panama's network.
- **National Signaling Plan**, defines the principles and the requirements that must be met in the following three basic parts of a network: (i) tones and announcements, (ii) user-network signaling, and (iii) signaling between exchanges. The signaling plan also defines the levels of the parameters that are involved in each of the forms of signaling indicated above, so that all the components of the networks that operate at the national level and their interrelation with international networks of telecommunications can operate in a coordinated and appropriate manner.
- **National Transmission Plan**, defines the rules and thresholds of the different transmission parameters in national and international telecommunication networks. These rules guarantee intelligible voice conversations, without excessive noise, adequate sound and the correct reception of data, which is essential for the wide variety of existing and future services that will be provided through telecommunications networks. This plan also aims to achieve an efficient, reliable and high-quality communications network. To achieve this objective it must be ensured that the transmission quality for telephone and non-telephone services is sufficiently high and that the different transmission impairments of a connection, such as attenuation, instability, echo, attenuation distortion and group delay, crosstalk, noises of diverse origins, errors of bits of different types, among others, do not exceed certain limits specified in the plan.

Chile

Telecommunication sector in Chile is mainly regulated by *Ley General de Telecomunicaciones* issued in 1982. It defines the global and primary definitions of telecommunications services (broadcasting radio, public services, limited services, intermediated services, among others). It contains the main sector principles like, promoting coverage, penetration and higher quality standards of services, fostering competition, tariffs regulation, creating incentives to the private sector, and executing market regulation to control market abuse. *Ley General de Telecomunicaciones* has had eighty modifications

across the thirty-five years since its publication to update it according to global trends and the dynamic of the sector, especially regarding the International Telecommunication Union (ITU) recommendations.

Apart from the general telecommunications law, which constitutes the basis of the sector, there are specific laws that have become necessary because of the whole progress and development of ICT technologies. For example, the Chilean government issued law 19223 to protect civilians from criminal networks, it also issued law 19.628 that regulates personal data information, and created a law to regulate electronic signatures. More recently, Chile has become a global benchmark on network neutrality by issuing law 20.453, which protects user privacy, intellectual property, and prevents child exploitation.

Colombia

ICT sector in Colombia is regulated by Law 1341 of 2009; it determines the general framework for public policy implementation on the sector, competitiveness regime, user protection, and laws regarding coverage, quality of services, investment promotion, technology development, and rational use of networks and radio-electric spectrum. This law takes into account the current environment of global telecommunications, allowing Colombia to exploit the sector. The law establishes a regime that facilitates entry of new competitors, lowering entry barriers and sunk costs. Further, it modifies spectrum regulation considering technology neutrality, technology convergence and spectrum auction mechanism. Furthermore, Law 1341 created *Agencia Nacional del Espectro* (ANE), and *Comisión de Regulación de Comunicaciones* (CRC). The former is an agency in charge of conducting and planning national radio-spectrum, the latter is an entity in charge of promotion of free competition, fighting against market abuse and designing an appropriate regulation for the sector.

Costa Rica

In 2008, the General Telecommunications Law (no. 8642) and the Strengthening and Modernization of Public Entities of the Telecommunications Sector Law (no.8660) were approved with the objective of organizing, modernize and regulate the telecommunications sector in Costa Rica.

The General Law of Telecommunications defines the general regulatory framework for network operators and telecommunications service providers. It creates the National Telecommunication Fund and defines its objectives. Also, this Law includes regulation mechanisms to the allocation and usage of radio spectrum.

The Strengthening and Modernization of Public Entities of the Telecommunications Sector Law has three primary objectives. First, to ease the regulatory framework of ICE (national operator of telecommunications) to ensure competition with other operators. Second, designs a rector (MICITT), a regulator (SUTEL) and an operator (ICE) of the telecommunications sector. Third, modifies the ARESEP Law (No. 7593) to establish SUTEL as the telecommunications regulatory authority.

The Radio Law (No. 1758) regulates radio and television services. However, the infrastructure that these services need is subject to the General Law of Telecommunications. The National Radio Control Unit, as part of the MICITT, supervises and regulates radio and telecommunication services.

Ecuador

Ecuador's telecommunication sector has had relevant regulatory changes concerning universal access, infrastructure laws, and competition rules. *Ley Orgánica de Telecomunicaciones* (LOT) of 2015 is the most important telecommunication's law; it contains the main principles, definitions, and goals that rule the sector. In general terms, the LOT promotes the development and strengthening of the sector; it fosters domestic and foreign investment to accelerate infrastructure and services deployment; it establishes full network neutrality, which finally protects consumers' welfare, and it follows ITU recommendations on physical infrastructure sharing like ducts, cables and radio stations.

In addition to *Ley Orgánica de Telecomunicaciones*, Ecuador promulgated on 2016 *Reglamento a la Ley Orgánica de Telecomunicaciones,* which defines the role of public entities in executing policy for the sector. Furthermore, the government issued *Ley Orgánica de Gestión de la Identidad y Datos Civiles and Ley del Sistema Nacional de Registro de Datos Públicos*; the former aims to protect personal data confidentiality and legitimize electronic documents, the latter orders, regulates and systematizes public data access and public data management.

Mexico

The laws that govern the telecommunication sector are the Mexican Constitution (reformed in 2013) and the 2014 Federal Law on Telecommunications and Broadcasting (*Ley Federal de Telecomunicaciones y Radiodifusión or LFTR*).

The Constitutional Reform strengthened the regulatory authority, mandated that the regulator´s rulings are no longer subject to suspensions through *Amparo* trials, and specialized courts were established. The law also increased the quality of decision making, by public consultations and regulatory impact analysis carried by the IFT. In addition, implementation of online platforms and tools to provide users with information about services and user´s rights have been created by the IFT during the past four years.

Spain

In 2014, Congress approved the reform to the General Law of Telecommunications, which actualizes the regulatory framework to bolster digital economy development. This law seeks to facilitate investments, eliminate entry barriers and promote competition and user protection. Also, it simplifies the deployment of new networks, promoting shared use of infrastructure and removing obstacles for new licenses. As well, ensures market unity and set the basis for investment in fixed and mobile ultrafast connections.

Likewise, the Law seeks to ensure the compliance of the European Digital Agenda objectives: 100% coverage of population of 10 Megabits per second (Mbps) broadband by 2020 and reach 50% of households subscribed to a 100 Mbps fixed broadband service by 2020.

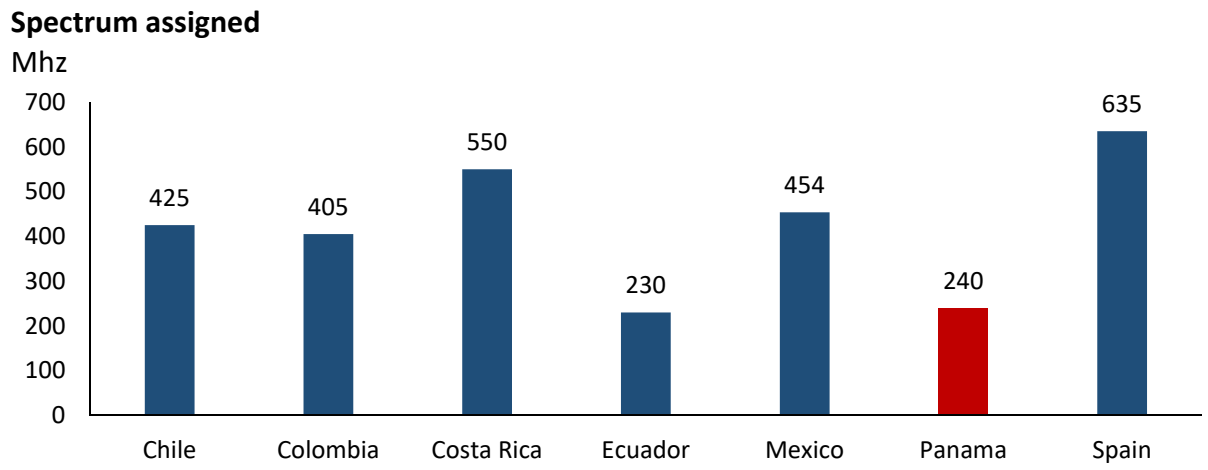
Table 2: General telecommunications laws

Country	Telecommunications Laws	Issue	Year	Source
Chile	*Ley 18.168*	General telecommunications law	1982	https://www.leychile.cl/Navegar?idNorma=29591
	Ley 19.223	Cyber-Security	1993	https://www.leychile.cl/Navegar?idNorma=30590
	Ley 20.453	Data protection	2010	https://www.leychile.cl/Navegar?idLey=20453
	Ley 19.628	Network Neutrality	1999	https://www.leychile.cl/Navegar?idNorma=141599
Colombia	*Ley 1341*	General telecommunications law	2009	http://www.mintic.gov.co/portal/604/w3-article-3707.html
Costa Rica	*Ley General de Telecomunicaciones*	General telecommunications law	2008	https://sutel.go.cr/sites/default/files/normativas/ley_general_de_telecomunicaciones.pdf
	Ley de Fortalecimiento y Modernización de las Entidades Públicas del Sector de Telecomunicaciones	Regulatory authorities	2008	https://sutel.go.cr/sites/default/files/normativas/fortalecimiento_y_modernizacion_de_las_entidades_publicas.pdf
Ecuador	*Ley Orgánica de Telecomunicaciones*	General telecommunications law	2015	https://www.telecomunicaciones.gob.ec/wp-content/uploads/downloads/2016/05/Ley-Org%C3%A1nica-de-Telecomunicaciones.pdf
Mexico	*Reforma a la Constitución Política de los Estados Unidos Mexicanos*	Regulatory authorities	2013	http://www.diputados.gob.mx/LeyesBiblio/pdf/1_150917.pdf
	Ley Federal de Telecomunicaciones y Radiodifusión	General telecommunications law	2014	http://www.dof.gob.mx/nota_detalle.php?codigo=5352323&fecha=14/07/2014
Panama	*Law No. 31*	General telecommunications law	1996	http://www.asep.gob.pa/
Spain	*Ley General de Telecomunicaciones*	General telecommunications law	2014	https://www.boe.es/buscar/pdf/2014/BOE-A-2014-4950-consolidado.pdf

Source: Regulatory Authorities

Spectrum Regulation

Figure 1 Spectrum assigned



Source: Spectrum Monitoring and telecommunications authorities.

Table 3: Standardization, spectrum management, numbering, IT

	Standardization / certification	Spectrum planning	Spectrum allocation	Spectrum assignment	Enforcement/ monitoring of law/regulation	Management of numbering resources
Chile	SUBTEL	SUBTEL	SUBTEL	SUBTEL	SUBTEL	SUBTEL
Colombia	CRC	ANE	ANE	MINTIC-ANTV	MINTIC-ANTV-SIC	CRC
Costa Rica	SUTEL/ECA	MICITT	MICITT	MICITT	SUTEL	SUTEL
Ecuador	ARCOTEL	ARCOTEL	ARCOTEL	ARCOTEL	SUPERTEL	ARCOTEL
Mexico	IFT	IFT	IFT	IFT	IFT	IFT
Panama	ASEP	ASEP	ASEP	ASEP	ASEP	ASEP
Spain	MINETAD	MINETAD	MINETAD	MINETAD	MINETAD	MINETAD

Source Broadband Policies for Latin America and the Caribbean. A Digital Economy Toolkit (OECD).

Panama

It is regulated through the National Radio-Electric Spectrum Frequency Attribution Plan (PNAF), and resolutions issued by ASEP. The PNAF is the main tool that includes the legal and regulatory elements for the national administration of frequencies. It also has the purpose of establishing the norms and parameters necessary to carry out an adequate administration of the radio spectrum.

The administration of the radio spectrum is defined as the combination of the administrative, scientific and technical procedures necessary to guarantee the efficient operation of radio communication equipment and services without causing harmful interference. ASEP is involved in the process of regulating and managing the use of the spectrum frequencies.

The first essential requirement for the proper use of the frequency spectrum is the division of the spectrum into independent parts, which are referred to as bands, each of which can be used by one or more radio communication services. The radio services are specified and defined by the International Telecommunications Union (ITU).

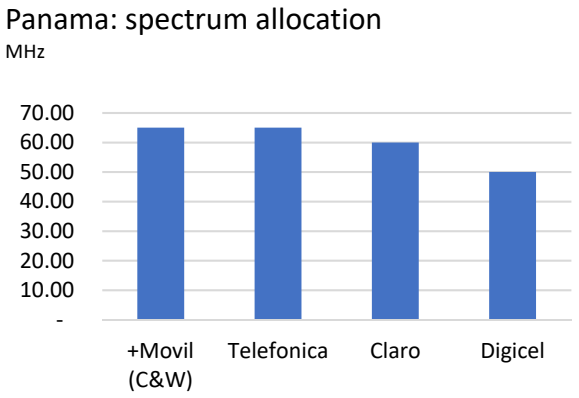
In Panama, the radio-electric spectrum ranges between the 3 kilohertz (KHz) and the 3,000 gigahertz (GHz) band, and it is recognized as national public property. The main body in charge of its use is the ASEP, who following the National Technical Plan for Telecommunications, and other local and international laws (i.e., ITU rules), established in 1997 (and modified in 2007) the PNAF. Depending on its use, the frequencies were divided into telecommunications and no telecommunications; the first under the ASEP jurisdiction and the later under the Ministry of Government and Justice.[27]

- In addition to the PNAF, Panama, through ASEP, has worked in the digital switch-over, to allocate segments of the radio spectrum band for IMT services, called the second dividend. In this sense, ASEP promoted the digital terrestrial television (DTT) project, which allows users to receive a free response, but in digital format, the contents of national channels, using a decoder box connected to a conventional antenna and your current television. Similarly, the digital signal can receive a video with the integrated DVB-T digital tuner. It should be noted that these digital receivers are available in some stores in Panama.
- The regulatory authority in pursuit of the commercialization dynamics of the decoder and television boxes with DVB-T digital tuner, recently held the meetings with the economic agents, in order to inform how the process of transition of the digital analogue signal will be developed, where there is digital coverage, the promotion plan for users, the digital channels assigned and, in turn, knowing and responding to their concerns. According to the most recent information published by ASEP, since September 14, 2011, the process of transitions has begun according to the phase schedule:
    - Phase I: As of September 14, 2011, television companies had 18 months to start digital transmissions in the provinces of Panama and Colon. Ended in March 2013.
    - Phase II: After Phase I, television companies have 18 months to start digital transmissions in the provinces of Coclé, Herrera, Los Santos and Veraguas. Ended in September 2014.
    - Phase III: After Phase II, television companies had 18 months to start digital transmissions in the provinces of Chiriquí and Bocas del Toro. Ended in March 2016.
    - Phase IV: After Phase III, television companies had 18 months to start digital transmissions in the province of Darién. Ended in September of 2017.

[27] According to Arias, Fábrega & Fábrega, ASEP assigns the frequencies to operators classified according to Zones and Ranges determined in the PNAF, who have to pay a frequency usage annuity to ASEP. This PNAF which at all times must be up to date contains a list of individuals and corporations who have been assigned frequencies by ASEP. Frequencies can only be used for purposes established in the license or permit granted by ASEP. Frequencies can be reassigned by ASEP without indemnity in the following cases: 1) for reasons of public interest or National security; 2) introduction of new technologies; 3) in cases of interference and; 4) to comply with treaties.

- Final Phase: by the end of 2018, analog television broadcasts will be turned off in different provinces of Panama, where 62% of the country's households are located.

Figure 2 Panama spectrum allocation



Source: Spectrum Monitoring and telecommunications authorities.

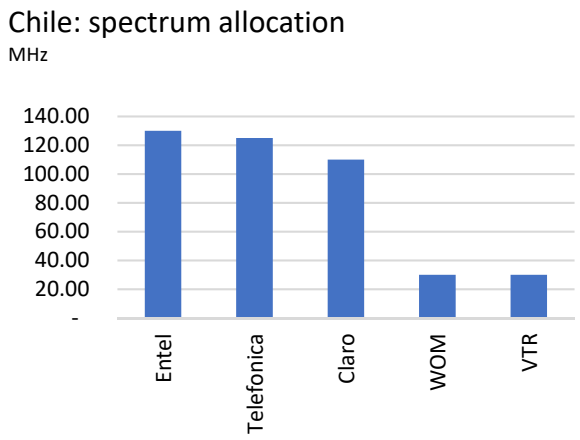
Chile

Law 18168 of 1982 *(Ley General de Telecomunicaciones)* establishes that radio-electric spectrum is a public good, in that sense, it belongs to everybody in the country and no one could own it, hence if someone wants to use the radio-electric spectrum, he should pay for limited time licenses. SUBTEL is the organism that regulates and administrates the radio-electric spectrum; it dictates technical norms for the use of the spectrum like, bandwidth allocation, operation norms, and security standards, among others. According to international standards, Decree 127 of 2006, promulgated by SUBTEL, is the Chilean general plan for the spectrum administration.

Between 2010 and 2014, 190 MHz were allocated to the market, using the 2.6 GHz band in 2012 and the 700 MHz band in 2014. These spectrum bands allow for broader coverage and velocity of new generation digital services, like 4G and 5G connections. Therefore, the contest was oriented to companies that could implement this kind of technologies (See Figure 3). As 700MHz band will improve in many senses digital services supply, the companies that allocate services at the band must fulfill norms that aim to redistribute profit. These norms include tariffs reduction, increase in coverage (especially in rural zones), and the obligation to offer interconnection.

Chile is one of the few countries in Latin America that uses comparative selection on spectrum allocation, “where the license is awarded to candidates that submit the best plan based on a series of commitments usually linked to some aspect of “social” or “public welfare” (e.g. coverage, technology, investment, prices, financial strength, etc.). Even if this mechanism recommended by the mobile industry, could potentially have nontransparent results as it can easily be designed to favor a certain operator”, (OECD 2016). Hence auction mechanism has become the most widely used allocation procedure as it is founded on related market-based methods that efficiently assign scarce resources.

Figure 3 Chile spectrum allocation



Source: Spectrum Monitoring and telecommunications authorities.

Colombia

Law 1341 of 2009 created *Agencia Nacional Del Espectro* (ANE) an agency in charge of designing and formulating, programs and plans related to monitoring and controlling radio electric spectrum. Apart from creating a specialized agency that gives technical support to the ministry of telecommunications, there have also been two main principles that have prevailed on spectrum regulation in Colombia since 2009. The first one is technology neutrality. The main idea is to allocate spectrum independently of the final use and technology adoption from the provider firm. Technology neutrality allows flexible use of the spectrum, which incentives multiple technology implementations and a greater variety of ICT services. The second principle is the introduction of a market mechanism to the assignment of licenses for the use of frequencies, mainly through auction mechanisms (Oviedo, 2011).

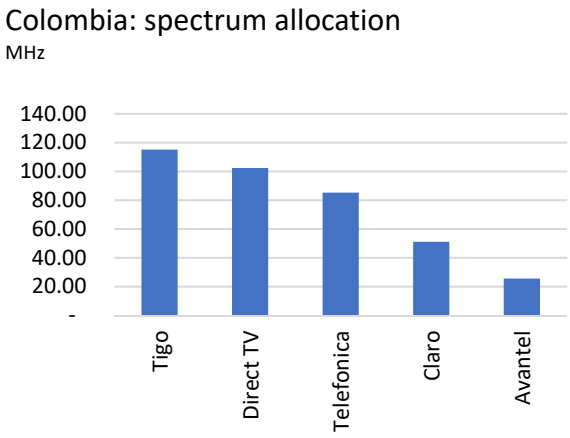
The more recent auction process in Colombia was the 4G auction in 2013; five companies participated in the auction: Direct TV Colombia, ETB, Claro, Telefonica and *Sociedad Futura Azteca*. During the auction, seven spectrum blocks for 4G implementation, three blocks on the AWS band and four blocks on 2.5 GHz band were simultaneously adjudicated. In addition to the price paid for the use of the spectrum, each participant was obligated to distribute a number of tablets to low-income people of the country, the dominants companies of the sector had to contribute with more tablets than the others. Table 4 shows the results of the auction.

Table 4 Results of the 4G auction in Colombia.

Company	Adjudicated Band	Total Value (LUC)	Tablets Obligation	Coverage on number of Municipalities
Claro	2.500 MHz band Open block of 30MHz	$ 119,995,886,000	309,630	660
Direct Tv	2.500 MHz band Open block of 30MHz	$ 71,856,366,000	30,000	57
	40MHz (reserved)	$ 77,565,288,000		
Avantel	AWS band (reserved)	$ 107,464,140,000	30,000	57
ETB	AWS band Open block	$ 195,749,940,000	67,246	
Movistar	AWS band Open block	$ 197,889,222,800	119,317	255
Azteca	No assignment			

Source: Ministry of information technologies and communications www.mintic.gov.co

Figure 4 Colombia spectrum allocation



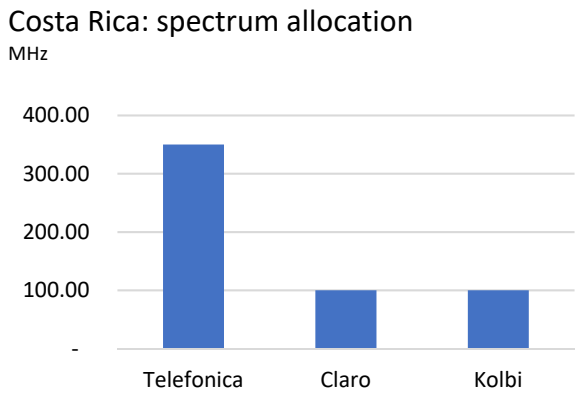
Source: Spectrum Monitoring and telecommunications authorities.

Costa Rica

The National Frequency Attribution Plan (PNAF), updated on February 2016, regulates the use of the radio spectrum. The plan is based on notes, resolutions recommendations and technical indications issued by ITU, recommendations of the World Telecommunication convention and regulation from the Agreement of the International Telecommunication Union. The MICITT executes and evaluates the PNAF, and it has to be consistent with the National Telecommunications Development Plan, International Treaties and Laws 8642 and 8660.

According to the PNAF, the radio-electric spectrum is composed of frequencies ranging between 3 KHz and 3,000 GHz, the airspace in which these radio-electric waves travel is National Public Property. Radio spectrum is allocated, since 2009, by auctions. The most recent bidding was in July 2017, when SUTEL assigned 70 MHz of IMT spectrum for 43 million dollars. The money is going to be used on FONATEL.

Figure 5 Costa Rica spectrum allocation



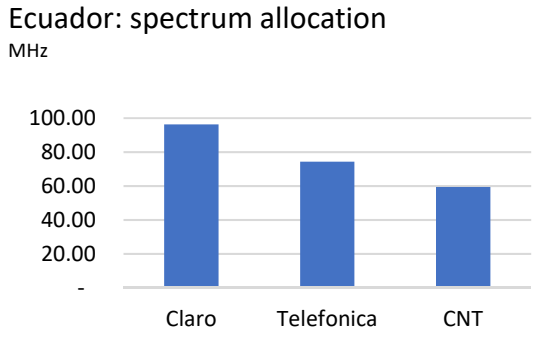
Source: Spectrum Monitoring and telecommunications authorities.

Ecuador

Ley General de Telecomunicaciones contains general definitions for spectrum management in Ecuador. Articles 93 and 94 establish ARCOTEL as the entity in charge of radio-electric spectrum assignment and establish goals for regulation, planning, and allocation of the radio-electric spectrum, which includes, technology convergence principles, fair and equitable allocation, protection from interference, and rational and efficient allocation. Besides Article 93, Ecuador has a national frequency plan, *Plan Nacional de Frecuencias* (PNF), that contains all definitions and technical specifications for exploitation and allocation of spectrum.

In 2015 the national government assigned 40 MHz of the 1.7 GHz band and 70 MHz of the 1.9 GHz band to deploy 4G technology across Ecuador, in the process, the government recollected 300 million dollars, one of the most substantial amounts collected in spectrum allocation. As in Chile, Ecuador did not use an auction process for the spectrum assignment; the government assigned spectrum based on discretionary rules. Figure 6 shows the current spectrum allocation for the leading telecommunication companies in Ecuador, Claro, CNT, and Movistar.

Figure 6 Ecuador spectrum allocation



Source: Spectrum Monitoring and telecommunications authorities.

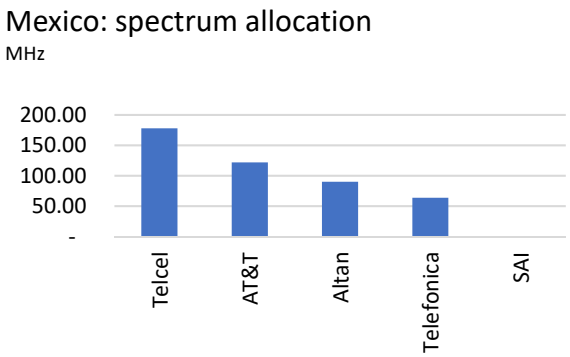
Mexico

The IFT, by Law, has the objective to ensure the efficient development of the telecommunications and broadcasting sector, including the administration and use of the spectrum. To this purpose, the IFT published the National Spectrum Plan 2017-2018 (NSP) in 2017.

The plan aims to increase and allocate spectrum, to make radio spectrum available for concessions of social use and has the purpose of improving the efficiency in the use of spectrum. Also, the NSP includes a plan to increase the allocated spectrum from 404 MHz in 2017 to 594 MHz in 2019. Moreover, with an efficient administration of the 700 MHz and 2.5 GHz spectrum bands, the IFT expects to increase the allocated spectrum to 1,007 MHz between 2019 and 2022.[28]

The allocation of the spectrum requires a bidding process, which is designed and supervised by the IFT. The last bidding process was in 2016, where ALTAN got 90 MHz of the 700 MHz spectrum band for the development of the wholesale shared network *("Red Compartida").* As of today, the allocation of the 2.5 GHz band is in process, and is expected to be assigned in 2018.

Figure 7 Mexico spectrum allocation



Source: Spectrum Monitoring and telecommunications authorities.

Spain

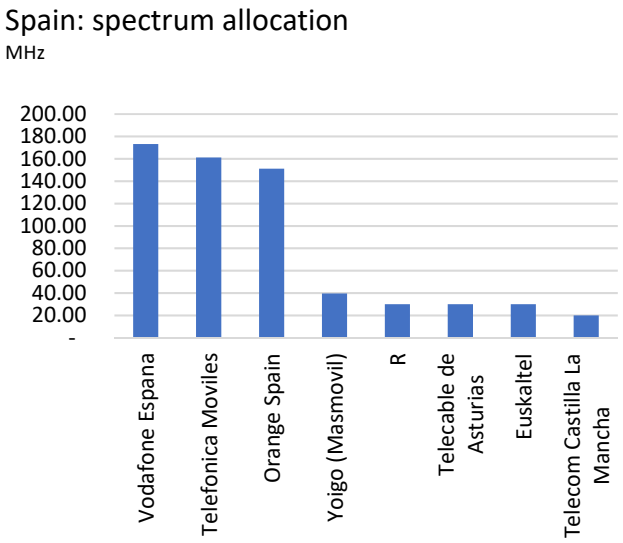
The National Frequency Allocation Table (CNAF), updated on October 2017, allocates and ensures the efficient use of radio spectrum. The Table is based on the regulation applicable to the European Union and resolutions of ITU, as well as other international organisms. The CNAF establishes a spectrum reserve for special purposes, delimitation of frequency bands to public administrators, and plans to continue benefiting from the use of spectrum. As in other countries, the radio-electric spectrum is composed of frequencies ranging between 3 KHz and 3,000 GHz, and the airspace in which these radio-electric waves travel is National Public Property.

[28] IFT (2017), IMT en México, más espectro para aplicaciones de Banda Ancha Móvil. http://www.ift.org.mx/sites/default/files/imtenmexico2017a_0.pdf

The Ministry of Energy, Tourism and Digital Agenda controls the radio spectrum usage. Its function regarding spectrum includes authorization of infrastructure and supervision of radio emissions. Also, it administrates a public registry of the concession holders. The spectrum is allocated by bidding processes.

In December 2017, the MINETAD published the 5G National Plan, which aims to allocate the 2,600 MHz, 3,600 MHz, 1,500 MHz and 700 MHz frequency bands as the second digital dividend. The plan has the objective of developing the use and adoption of 5G technology. It is expected that the MINETAD announces the bidding process between the first half of 2018 and the end of 2020.

Figure 8 Spain spectrum allocation



Source: Spectrum Monitoring and telecommunications authorities.

Investment

Panama

The legal framework that regulates foreign direct investment in Panama, including the telecommunications sector, has one of its central elements in Law No. 54 of July 22, 1998, on Legal Stability of Investments.[29] This regulation grants national treatment to foreign companies and capitals, although it requires that the operations that benefit from it have a minimum volume of two million dollars. The telecommunications law specifically authorizes majority equity participation for foreign private investors. Nonetheless, the direct or indirect participation of foreign governments is expressly forbidden.[30]

In addition to Law No. 54, Panama created a Universal Access Fund under Law No. 29 of August 11, 2008

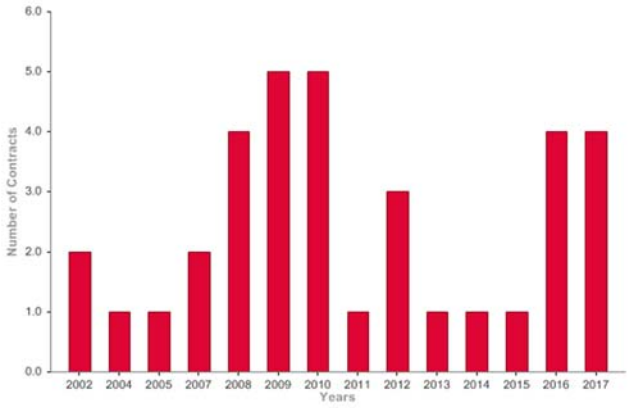
[29] http://www.innovacion.gob.pa/descargas/acceso_universal_Resolucion_No_6.pdf
[30] http://www.mef.gob.pa/es/Documents/Ley_54_Inversionistas.pdf

(modified by Law No. 62 of 2012) to provide technology solutions for access to the Internet, mobile, and fixed telephony to areas of difficult access or where economic conditions would make it difficult for the residents to acquire such services.[31] Some of the main provisions are:

- The entities responsible for the administration and implementation of the fund are ASEP and AIG.
- To contribute with funds, the following providers are obliged to contribute with 1% of their taxable income, including the one for incoming international calls to Panama: Local Telephony providers, National Telephony providers, International Telephony providers, Mobile Service Providers, Telecommunication Transportation providers, and Internet Service providers.
- Also, 10% of the universal services and access fund is for financing research and development activities, and it should be transferred to the National Science and Technology Innovation Fund *(Fondo Nacional de Ciencia Tecnología e Innovación or FONACITI).*
- A Special Board designates the carrier for a particular project, projects incorporating multi-carriers are also permitted. There is no specific subsidy for broadband; it would be included in access to the Internet through the Universal Access Fund.

Panama is also promoting investment through Law No. 41 of 2007 (modified by Law No. 45 of 2012), which establishes benefits and incentives for multinational companies, such as exemption in income and value-added taxes.

Figure 9: Number of ICT contracts in Panama



Source OVUM.

Chile

Public investment on ICTs has been intensive primarily on rural and low-income urban zones that are unattractive for private telecoms companies as the benefit of selling ICT services does not cover production costs, especially sunk infrastructure deployment costs. To increase and efficiently

[31] It is estimated that the budget of the Fund is around 10 million dollars according to the Development Centre Studies Innovation Policy in Panama: Design, Implementation and Evaluation, OECD, 2015.

concentrate ICT public infrastructure, decree 353 of 2001 approved regulation to create the *Fondo de Desarrollo de Telecomunicaciones* (FDT), a financial instrument funded by the government and administrated by a particular communication counsel. This counsel designs and adjudicates telecommunications projects through public contests to private firms and institutions that fulfill specific conditions and requirements.

Each year SUBTEL publishes MEMORIA, a document that presents the current stage of the central telecommunication plans subsidized by the FDT. Some of the primary programs included on MEMORIA 2016 are: *Conectividad Para la Educación* program which aims to improve human capital formation through ICTs; *Zonas Wi-Fi* program that consists on deploy free Wi-Fi zones across Chile, focusing on isolated areas; *Ampliaciones Satelitales* plan which aims to increase satellite connections on Isla de Pascua and Archipiélago de Juan Fernandez; *Proyecto Fibra Óptica Austral* that aims to increase digital connectedness from Puerto Montt to Puerto Williams, and Telefonía Móvil Rutas del Fuego, a historically program that connect the most isolated zones of the country. Table 5 shows the total amount of subsidies and the coverage for each program.

Table 5 Chile main ICT subsidized programs

Project / Program	Granted Subsidy	Telecommunication Service	Coverage
Conectividad para la Educación	$ 4,671,000,000.00	Data transmission (Free Internet)	7,844 Educational institutions
Zonas Wi-Fi	$ 8,466,655,714.00	Data transmission (Free Wi-Fi)	15 Regions, 344 Localities
Ampliación Enlaces satelitales	$ 3,705,680,000.00	Intermediate service of data transmission	Isla de Pascua y Juan Hernandez
Telefonía Móvil rutas Tierra del Fuego	$ 2,110,663,610.00	Mobile phone supply	1 Region
Proyecto Fibra Óptica Austral	$ 64,148,400,000.00	Intermediate infrastructure service	3 Regions

Source MEMORIA 2016.

Colombia

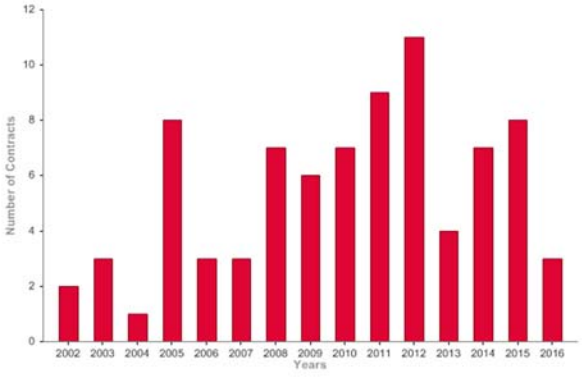
Law 1341 of 2009 established the *Fondo de Tecnologías de la Información y las Comunicaciones* (FONTIC), an entity that belongs to the Ministry of information technologies and communications, which aims to finance programs, plans, and projects that facilitate ICT universal access, focusing on isolated regions' coverage, and digital penetration for the vulnerable population. FONTIC is funded by the revenues of spectrum auctions, licensing fees, fines, and a fraction of the government budget, among others.

In addition to investment in physical infrastructure and services, FONTIC has assigned a large part of its budget to subsidize human capital investments. It launched undergraduate scholarships promoting high school students to enroll on ICT studies (professional or technical), it also offered scholarships for graduate studies abroad, that encourage the creation of high skill ICT experts that will contribute in the

future development of the country. In 2016, FONTIC invested 322 million dollars in ICT projects (0.11 % of GDP).

The private telecommunication sector in Colombia has been actively investing over the last years. In 2016 Claro Colombia chose Ericsson for a transformation of its operations and business support system aimed to speed service rollout, in 2015 Gemalto was selected by Tigo to deliver unique M2M solutions. Also, Telefonica has selected VPI systems' One Plan software for its Network Optimization across Argentina, Brazil, Chile, Colombia, Germany and Peru (OVUM). Figure 10 shows the evolution in the number of ICT contracts over the last decade in Colombia, in which 2012 was the year with the highest number of deals.

Figure 10 Number of ICT contracts in Colombia



Source OVUM.

Costa Rica

The General Telecommunications law allows participation for foreign and national private investors without restrictions. In 2013, Costa Rica signed an OECD agreement to attract more foreign investment. After signing the contract, Costa Rica committed to providing foreign investors the same treatment as the national, with exceptions in electricity, mining, transport, land and agriculture, and aviation.[32]

FONATEL leads investment in the telecom sector; a national fund created as part of Reforms and through the General Telecommunications Law to ensure universal access and services to reduce the digital gap. The Fund gets resources of three kinds: payments for radio spectrum concessions *("Canon de Reserva de Espectro Radioeléctrico"*), an annual charge to operators (*"Canon de Regulación")* and a contribution payable by the operators of 1.5% to 3.0% of their gross income. At the end of 2016, the fund had 294 million dollars.[33]

[32] OECD (2013). Investment Policy Reviews, Costa Rica 2013.
[33] SUTEL (2016), Rendición de cuentas y Transparencia, Fondo Nacional de Telecomunicaciones (FONATEL), Acceso Universal, Servicio Universal y Solidaridad.

The fund provides for free, internet access and telephone services to medical centers, community centers, public schools and isolated villages. For this purpose, the fund has five programs with an expected total investment from 2017 to 2022 of 315 million dollars, including 35.3 million in 2017.

Table 6 FONATEL Programs

FONATEL's programs

Program	Objective	#Projects	Investment expected 2016-2022 (USD million)
Comunidades Conectadas	Ensure access to fixed voice and internet services to rural and vulnerable population.	26	133.6
Hogares Conectados	Subsidize the acquisition of a fixed broadband subscription and a device for low-income households (quintile 1 to 3).	1	127.5
Centros Públicos Conectados	Provide equipment to exploit ICT services in public centers (hospitals, public schools)	1	20.0
Espacios Públicos Conectados	Provide infrastructure and equipment to public places (parks)	1	32.9
Red de Banda ancha solidaria	Increase the national high-speed broadband network	1	1.0
Total		**30**	**315.0**

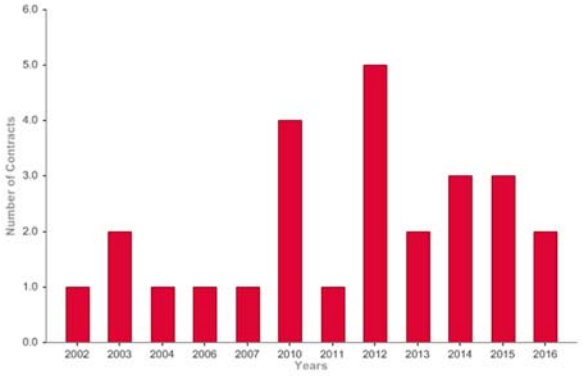
Source: FONATEL, 2016.

Ecuador

One of the main instruments for telecommunication investments in Ecuador is *Fondo de Desarrollo de las Telecomunicaciones* (FODETEL), which is a financial fund managed by MINTEL that allocates resources to universal access projects on rural and isolated urban zones of the country, especially the Amazonia and Galapagos. The national public investment report of 2015 exhibited the government´s investments on SUPERTEL's technology adequacy, INFOCENTROS network extension, expansion of TELEMEDICINE e-health program, incentives on ICTs innovation, connectivity of public schools, the national broadband program, and the digital government program, among others.

Investment participation of private companies has also been relevant on Ecuador´s telecommunications sector. On 2015, TELCONET, an internet provider company, invested on a 7,000-km submarine network "Pacific Caribbean Cable Systems" (PCCS) that connected Ecuador, Panama, Colombia, Aruba, Curacao, British Virgin Islands, and the United States. Furthermore, in 2016 Ecuador operator CNT selected Aptilo Networks to enable Wi-Fi services across the country, which enabled the rapid growth of the Wi-Fi network (OVUM). Figure 11 shows the relevant number of ICTs contracts over the last years in Ecuador; in which 2012 was the year with the highest number of telecommunication contracts in the private sector.

Figure 11 Number of ICT contracts in Ecuador



Source OVUM.

Mexico

For the telecommunications sector, 100% foreign direct investment is permitted. Besides, the Constitutional Reform (2013) allowed the entrance of Mobile Virtual Network Operators (now, they had more than one million subscriptions). The Constitutional Reform promoted the foreign and national investment in the telecommunication sector by reducing the cost to operators and establishing a robust regulatory framework. From 2014 to 2016, the cumulated private investment in the telecommunication was 207,000 million pesos. Also, the share of foreign direct investment that represents the telecommunication sector increased from 5% in 2013 to 8% in 2015. The key example in the promotion of investment in Mexico is the project of the wholesale shared network (*Red Compartida*) that will represent 7 billion dollars of investment during the life of the project.

Spain

According to the General Telecommunications Law, and according to international guidelines, national and foreign companies can exploit and offer telecommunications services. There are no limitations in the ownership share that foreign investors can have in the telecommunications enterprises.

Also, the Universal Service program ensures access to basic telecommunication services to all users, independently of their location. The basic services include broadband access with at least 1 Mbps from a public place or a fixed telephone line. The Ministry of Energy, Tourism and Digital Agenda supervises the program. Whenever the conditions of the free market do not result in the supply of the services, the Ministry will designate an operator to ensure access to telecommunication services. The operator will be designated by an auction or bidding process. The costs are financed through the National Universal Fund, which receives contributions from all operators.

In December 2017, the MINETAD published the Smart Cities National Plan (*Plan Nacional de Ciudades Inteligentes, PNCI*), which seeks to improve the efficiency of public services through ICTs. For example,

WIFI spots in public transportation and parks, pilot programs to develop a 5G network and the promotion of smart tourism. The Plan comprises an investment of 188 million euros. [34]

Mergers and Acquisitions

Panama

Panama´s main regulation regarding mergers and acquisitions (M&A) is established in Law No. 32 of 1927 (Corporations Law), the Executive Decree 18 of 1994 (which establishes the taxable regime for M&A transactions), Law No. 4 of 2009 (Limited Liability Company Law) and the Commercial Code, which is supplemented by the Civil Code.

In particular, for telecommunications operators, M&A are governed by the terms of the concession agreement according to Chapter V of Law No. 31 of 1996. One of the key examples in the sector is the concentration of October 14, 2004, in which Telefónica Móviles, the company that manages the mobile telephony assets of the Telefónica Group, closed the acquisition of 100% of BellSouth Panama shares, with the authorization of Panama´s government. Also, Liberty Global in 2016 acquired Cable & Wireless Communications, which owns the incumbent telco Cable & Wireless Panama. The deal has enabled Liberty Global to combine CWP's businesses in Panama and the Caribbean with its operations in Chile and Puerto Rico.

Besides, ACODECO has the faculty to approve M&A transactions to avoid concentrations that hurt competition not only in the telecommunications sector but also in other key sectors in Panama. ACODECO also developed the "Guide for the Control of Economic Concentrations" (Resolution No. A-31-09 of July 16 of 2009, Guide on Concentrations) to provide a robust framework for M&As. As a general matter, Articles 21 to 29 of the Law No. 29 of 1996 regulate the control of mergers under the title of "Economic Concentrations."

Chile

In Chile*, Fiscalía Nacional Económica* (FNE) is the authority in competition matters, and it is in charge of preventing potential anticompetitive concentrations. The FNE investigates and analyzes concentration operations according to Decree 211 of 1974. Also, this authority enacted a resolution that provides the guideline to validate or deny a concentration and has the power to supervise possible infractions to concentration thresholds promulgated on Decree 211. M&A in the telecommunication sector is regulated by the *Subsecretaría de Telecomunicaciones* (SUBTEL), which dictates laws and parameters that provide a competitive environment for the development of the sector. As an example, on Resolution 48 of 2016, the FNE with the cooperation of SUBTEL legalized the fusion between Telefónica Chile S.A and Telefónica Larga Distancia S.A.

[34] MINETAD, 2017. http://www.red.es/redes/

Colombia

Mergers and acquisitions are regulated by *Superintendencia de Industria y Comercio* (SIC), and *Superintendencia Financiera* (SDF). On the one hand, SIC is the competition authority, ex-ante it verifies that mergers and acquisitions are not violating competition standards (market concentration, potential competition, market dominance, and entry barriers), contained on Law 1340 of 2009, and Resolution 12193 of 2013. On the other hand, SDF supervises that the M&A transactions meet financial requirements, for instance, each operation should not cause a disadvantage for minority shareholders, and must contain a complete five years projection study of financial sustainability, risk management analysis, product analysis and tariffs structure.

Comisión de Regulación de Comunicaciones (CRC) gives technical support to SIC in telecommunications concentrations and provides ex-ante regulation that must be fulfilled in each M&A process. For example, in 2014 Tigo merged UNE and created a leading company to compete with Claro and Movistar, the dominant companies in the sector. The merger was approved by the SIC, with an obligation of giving back spectrum to the government, since CRC regulation establishes that each company could possess a maximum of 85 MHz of spectrum, and UNE and Tigo had 135 MHz of the spectrum after the concentration.

Costa Rica

Mergers and acquisitions need to be approved by SUTEL. Operators must present a request, and SUTEL has 30 days to answer. After that, SUTEL will approve the operation if it does not affect competition, consumer interests or free development of the telecommunications sector. Also, SUTEL will not approve a merger or acquisition if it results in an increment of market power that may affect consumers. During this process, COPROCOM assists SUTEL with analysis regarding the implications in other markets such as publicity, audiovisual content, etc.

In 2016, SUTEL approved the concentrations of Celestron S.A. and Multivision TV S.A, and Emisoras Unidades de Guatemala S.A. and Central de Radios CDR S.A. The two operations were approved taking into account that they did not represent an obstacle to fair competition in their respective markets.

Ecuador

Ley Orgánica de Regulación y Control del Poder de Mercado promulgated in 2011, is the law that regulates market power and concentration of all industries in Ecuador. Article 15 establishes that every case of market concentration must be examined, regulated and sanctioned by *Superintendencia de Control del Poder de Mercado*, Ecuador's competition authority. Furthermore, every vertical and horizontal integration that increases market concentration above thirty percent must be notified at the competition authority to receive the authorization of the market operation. ARCOTEL, as the specific regulator of the ICTs also has the authority to investigate and sanction firms that are not meeting concentration thresholds standards on market services, or radio-electric spectrum use.

Mexico

Mergers and acquisitions of telecommunications companies are regulated by the Plenary of the IFT. The parties have to inform the intention of a merger or acquisition, previous to the operation, to the IFT according to the article no. 86 of the Federal Law of Competition. Then the IFT has from 60 to 100 days to deliberate the approval, prohibition or conditional approval.[35]

One of the more important acquisitions after the Reform was the acquisition of Nextel Mexico by AT&T for a price of about 1.9 billion dollars in 2015. Also in 2015, AT&T bought "Grupo Iusacell" for about 2.5 billion dollars. Now, AT&T has a spectrum share of 30% and is the second largest operator in the country.

Spain

Mergers and acquisitions in Spain are regulated by the CNMC and by the European Commission. Large mergers that involve other European countries are regulated by the European Commission Regulation and the Implementing Regulation. The Merger Regulations contains the regulation frameworks, whereas the Implementing Regulation defines the process to get a transaction approved (notifications, deadlines, etc.). A merger that does not impede effective competition in the EU is approved unconditionally, whereas is prohibited if impede effective competition, for instance, a merger would be prohibited if the resulting company could have significant market power. However, a merger that distorts competition can be approved under the condition for the parties to make a commitment to restoring competition, as an example, by selling part of the business to another player.

The CNMC regulates mergers that have purely local effects and smaller mergers through the Competition Defense Law. The Commission analyses if the transaction results in an increment of market power that could impede competition. The transaction is approved if it does not impede competition otherwise it will be prohibited. If it is prohibited, the resolution can be revised by the Minister Council in the next 15 days.

[35] IFT (2017). http://www.ift.org.mx/tramites/notificacion-de-concentracion

Table 7: Mergers and acquisitions

Mergers and Acquisitions

Country	Mergers and acquisitions	Status
Colombia	Millicom and Ola (2006)	Approved
	Comcel and Claro (2012)	Approved
	Grupo GTD and Flywan (2012)	Approved
	Millicom and Une (2014)	Approved
Chile	Grupo Matte and Entel Chile (2005)	Approved
	Telmex and Chilesat (2005)	Approved
	Telmex and ZAP TV (2007)	Approved
	Entel and Transam (2010)	Approved
	Entel and Will S.A (2010)	Approved
	Liberty Global and VTR (2014)	Approved
	Nextel Chile and Novator (2015)	Approved
Costa Rica	UFNET Costa Rica and Ufnet Latam (2017)	In evaluation
	UFNET Telecom and RSL Telecom (2016)	Approved
	CELESTRON and Multivision TV (2016)	Approved
	Emisoras Unidas Guatemala and Central de Radios (2016)	Approved
	AS Media y Multivision TV (2016)	Approved
Ecuador	Otecel S.A and Telefónica (2005)	Approved
	Telmex and Ecutel (2007)	Approved
Mexico	Nextel Mexico and AT&T (2015)	Approved
	Grupo Iusacell and AT&T (2015)	Approved
Panama	Telefónica Group and BellSouth Panama (2004)	Approved
	Liberty Global and Cable & Wireless Communications (2016)	Approved
Spain	KKKR, Telefonica, and Telxius (2017)	Approved
	Yoigo and Masmovil (2016)	Approved
	Orange and Jazztel (2015)	Approved

Source: Costa Rica- Sutel, Mexico-IFT, Spain-European Commission. OVUM.

New regulation: policy and outlook and digital policies

Panama

Panama developed the Strategic Plan for Broadband – 2022, managed by the National Authority for Government Innovation *(Autoridad Nacional para la Innovación Gubernamental or AIG),* which contains the following objectives: (i) universality of connectivity, (ii) increase the adoption and use of ICTs, (iii) foster broadband affordability and ICTs, (iv) promote the creation of contents and local innovation through entrepreneurship, (v) promote competition, (vi) boost Panama´s economy, (vii) increase in the competitiveness of companies, and (viii) improve public services related to government, education and health.

This policy establishes three specific plans in order to fulfill the objectives mentioned above:

- Connectivity Plan (access), aims to reach 47.5% of broadband penetration (fixed and mobile aggregate), 83.5% of Internet penetration and 88 Kbps of international connectivity per user with speeds ranging from 5 Mbps up to 100 Mbps.
- ICT Plan (adoption and use), divided by sector, with 26 specific initiatives that rely on existing projects but pursue more ambitious objectives to achieve the adoption and universal use of Broadband, as well as the transformation of different sectors, especially through an increase in affordability and digital literacy.
- Action Plan on Public Policy and Regulation (for access, adoption, and use) with 26 priority lines of action, which act as facilitators and execution mechanisms to make the Connectivity Plan and the ICT Plan a reality.

With the purpose of achieving the objectives set for the AIG, this entity designed a National Strategic Digital Agenda. The Agenda proposes strategic guidelines applicable to all government entities about the application and use of ICT technologies for the development of the Information Society, provision of digital services to citizens, and the necessary transformation and modernization of the government entities and public administration.[36] All the new programs and improvements to past policies contribute to the adoption of ICTs in different sectors, transforming Panama in a digital country.

Also, Panama has promoted and worked on a new regulation that is consistent with the digital ecosystem. For example:

- Adoption of IPv6 by facilitating educational and awareness activities such as forums, seminars, and training.[37]
- National Strategy on Cyber Security, through the ratification of the Budapest Convention on July 2014 and the development of new regulation.
- Similarly, AIG has implemented different programs for improving the digital adoption, such as:
    - "InternetParaTodos," in which the Government seeks the participation and inclusion of all the population in the use of ICTs through a national network that offers access to the

[36] http://innovacion.gob.pa/descargas/Agenda_Digital_Estrategica_2014-2019.pdf
[37] http://www.anatel.gov.br/

free wireless internet. The project includes the installation, service, and maintenance of 1,104 access points distributed in 41 cities and towns throughout the country. Since its start in January 2010, the network has, as of December 2012, more than 950,000 registered users.

- "Infoplazas" began in 1998 and its implementation since 2000 with a pilot program. Its mission is to facilitate access and good use of the Information Society, incorporating technology into the daily environment. Infoplazas has community centers with public access to computers, with training programs and with free Internet access.

Other programs regarding e-applications in government, education, health and other sectors are analyzed deeply in Volume 1.

Panama´s government has not only promoted ICTs adoption in the programs and plans mentioned above but also has established specific goals regarding the penetration and access to telecommunications in the Strategic Plan of Government 2015-2019. In this plan, the government expects to implement a National Broadband Network Internet Band with greater coverage, decrease the digital gap, and generate e-government applications for a Smart Nation. It has also set the goals to achieve this objective through the following indicators: Fixed Broadband Penetration of 11% (subs/population); Mobile Broadband Penetration of 34% (subs / inhabitants); Internet users of 80% (user / inhabitants), and update the current systems and launch 450 online administrative procedures, as well as the programs *Panama Informa, Apps ciudadanos de Gobierno Abierto,* and *Identidad Digital* (certificate and signature).

Chile

Chile's digital agenda is the primary national digital policy; it is a roadmap proposed by many members of the Chilean government to move forward to the digital development of Chile inclusively and sustainably through the information technologies. Its strategic pillars are, "Digital rights for everyone" which aims to develop a normative framework for the digital ecosystem, "Digital connectedness" which consists of extending quality digital access to all the population. "Digital government" which has the primary goal of supporting and fostering implementation of online government services. "Digital economy" consists of promoting innovation and productivity through ICT. Lastly "Digital competences" aims to improve human capital formation through technology implementation.

In addition to the national digital agenda, recently Chile's telecommunications authority SUBTEL has been working on laws that aim to improve users and providers welfare. One of these laws is *Ley de Velocidad Garantizada de Internet*, which obligates telecom companies to provide internet plans that guarantee a minimum average of internet velocity and reduce users' uncertainty for purchasing plans. Another recent law is Multibanda/SAE; it establishes a normative framework for homologation and inscription of cell phones in Chile, in fact, to receive messages from the alert emergency system (SAE) it is necessary that the cell phone has the corresponding inscription.

Colombia

In Colombia, ICT development has been a relevant task of government's agenda. As in many other Latin America countries, the main roadmap for the sector is the digital agenda, which contains 2014-2018 goals for infrastructure deployment, development of applications, ICT implementation, and services proliferation. Infrastructure deployment strategies focus on increasing coverage and penetration through free Wi-Fi zones, community centers on rural zones and an efficient spectrum allocation that increases the supply capacity of telecommunication providers. The government has also devoted significant efforts to the development of applications, it has applied entrepreneurship capacitation, and the formation of human capital oriented to ICTs, and has fostered e-commerce, e-health and e-government immersion in society.

Apart from the programs of digital agenda, the Ministry of Information and Communication Technology has been working on regulation and policies that will enhance ICTs development in Colombia. Some of them are a transition to IPv6 internet protocol, first for public entities and then for all the population; reconfiguration of digital government policy; creation of an inter-sectoral committee for digital economy development (CIDED); regulation regarding human exposure to electromagnetic fields and a new model of cybersecurity risk management. The ministry publishes new regulation and policies in progress on its webpage to receive feedback and comments from the citizenship.

Costa Rica

In 2009, the government published the Telecommunications Development National plan 2009-2014 with the objective of ensuring universal access to telecommunication services. It had 4 action axes: 1) Telecommunications, which seeks to expand cellular and broadband coverage, transition to digital technologies (TV and Radio) and ensure interoperability and interconnection; 2) Economy, which seeks to ensure the use of ICTs and promote competition and productivity; 3) Environment, which seeks to ensure a sustainable development of ICTs; and 4) Social, which seeks to ensure coverage and ICTs services to vulnerable regions of the country.

After the first Telecommunications Development National Plan, the government published a second National Plan for the period from 2015 to 2021. The new National Plan focused on digital inclusion and consolidation of competition-enhancing service quality. In this line, the authorities created a Digital Agenda and a Supportive Digital Agenda (Agenda Digital Solidaria) with the objective of promoting the development of telecommunications sector and ICTs usage in Costa Rica. The latter being focused on vulnerable communities.

The main pillars are: 1) Digital Inclusion; with the main objective to increase the proportion of individuals using internet to reach the average level of OECD countries; 2) Digital Economy, with the main objective to achieve 100% of households with Digital TV in 2017, and 3) E-government and transparency, with the main objective to improve the quality of broadband connection and that 80% of the population have access to broadband with the average velocity levels of OCDE countries.

Ecuador

Ministry of telecommunications and information society (MINTEL) is the leading entity of ICT development in Ecuador, it designs policy programs and supervises their implementation. MINTEL's route map is contained on digital agenda 2016-2021, it contains all telecommunications' goals besides policy instruments and guidelines to achieve them. As well as it appears on some others digital agendas in the region, universal access is Ecuador's digital agenda main goal, it reduces country's inequality, and increases worker's and firm's productivity. Infrastructure deployment is essential to achieve universal access; some programs include the construction of public community centers in isolated zones, investments incentives to the private sector, a regulation that guarantees efficient and fair use of radio-electric spectrum and infrastructure sharing regulation.

Regulation is a necessary complement to digital programs and development of the sector, ARCOTEL the entity in charge of designing and executing regulation is working on a sort of laws that will improve sector's efficiency. Some of them relate with the quality of services updating regulation; rules for large advertisement through mobile and fixed phones; regulation for physical infrastructure tunneling; norms for cell phone homologation; infrastructure sharing updating regulation; updating interconnection regime according to actual tendencies and principles.

Mexico

In 2013, Mexico designed and started the implementation of the National Digital Strategy (EDN) 2013-2018. The primary objective was to build a digital Nation in which technology and innovation help to achieve Mexico's development goals. The Strategy sets out the challenges Mexico faces in the digital context and the way it will cope with them through five major objectives: 1) Government Transformation, 2) Digital Economy, 3) Quality Education, 4) Universal, Effective Health, and 5) Public Safety.

In order to achieve the adoption and use of ICTs, and each of the five objectives of the National Digital Strategy, five key enablers, which are the following cross-cutting tools, have been proposed: 1) Connectivity, 2) Digital inclusion and skills, 3) Interoperability, 4) Legal framework and 5) Open data.

Spain

The Digital Agenda for Spain, approved in 2013, is the Government's strategy to develop the digital economy and society. According to the Ministry of Energy, Tourism and Digital Agenda, the Digital Agenda "sets the ICT and e-Administration roadmap to achieve the goals of the Digital Agenda for Europe in 2015 and 2020. The objectives, lines of action and plans established in this Digital Agenda are intended to encourage the creation of employment opportunities and economic growth through the smart adoption of digital technologies, thus contributing to the collective effort of promoting the

economic recovery of the country. The Agenda adopts 32 key indicators which comprise both the Digital Agenda goals for Europe and additional specific goals for Spain".[38]

The Agenda aims to cover 100% of the population with 30Mbps speeds and achieve 50% uptake of 100Mbps connections by 2020.

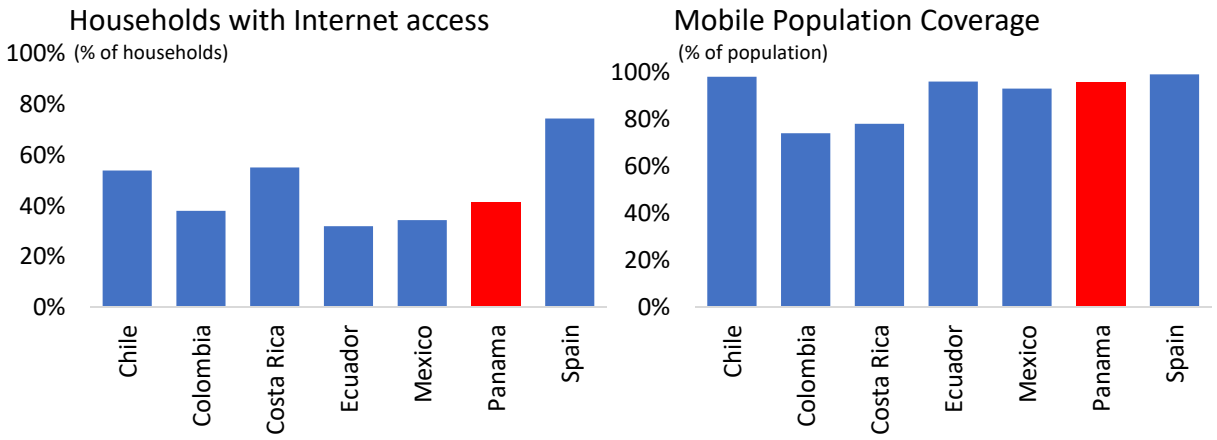
In December 2017, the MINETAD published the 5G National Plan (Plan Nacional 5G) with the objective to boost the development of 5G technology from 2018 to 2020. The plan seeks to promote the early use and contribute to investigation, development, and innovation of the technology.[39]

The plan has four central actions to develop. First, the administration of the spectrum allocation to ensure the availability of bands to offer 5G services. Second, the promotion of the investigation, development, and innovation through pilot programs and investigation programs. Third, the development of a regulatory framework to promote investment. Lastly, the plan seeks to promote international coordination and cooperation to improve the implementation of 5G technology in the world.

Access and quality

Figure 12, 13 Access

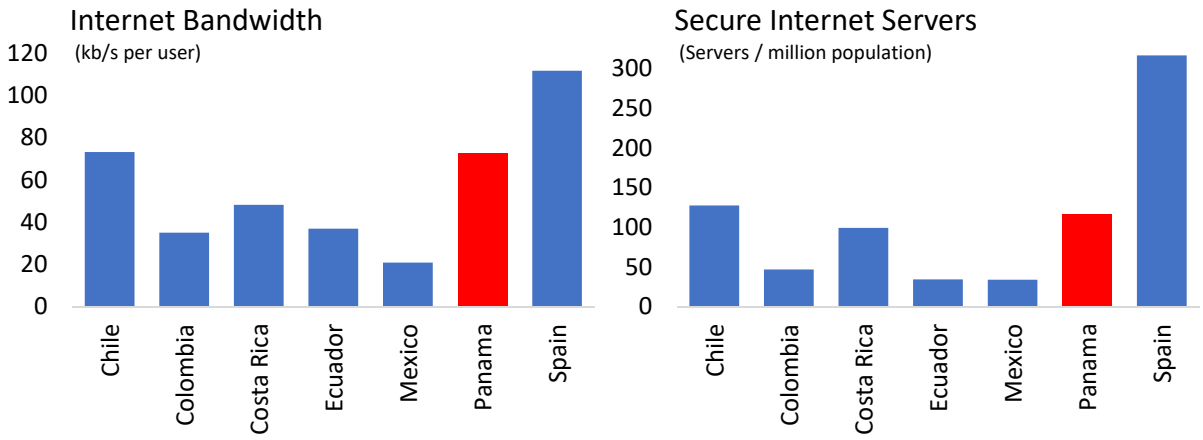
Access



Source Networked Readiness Index, 2016. WEF.

[38] Digital Agenda for Spain. Ministry of Energy, Tourism and Digital Agenda, 2013.
[39] MINETAD (2017), Plan Nacional 5G 2018-20.

Figure 14, 15 Quality



Source Networked Readiness Index, 2016. WEF.

Panama

Regarding access, operators with a dominant position must provide access to their infrastructure at non-discriminatory prices and conditions. In 2006, the ASEP decided that the local basic telecommunication service operator (operator with a dominant position) must establish in its network the technical means necessary for the provision of the local loop to all concessionaires who so request.

Access is also promoted by the imposition of a tariff system for concessionaires in which prices for telecommunications services offered under an effective competition regime are set by the concessionaires. Despite being under a regime of limited competition, the tariffs for mobile telephony services are set freely by the two existing concessionaires; however, in exceptional cases, such as in the existence of restrictive practices to competition, the ASEP may impose competitive tariffs to the concessionaires.

Also, mobile number portability has encouraged access through more competition in the mobile sector, which doubled from 2012 to 2017 (93,919 to 185,389).

Concerning quality, ACODECO has implemented a program of corporate social responsibility "Responsible Economic Agent," which allows companies that wish to join this program and thus provide their consumers with a high-quality standard of customer service, with the appropriate guidance of the ACODECO.

This program promotes the resolution of complaints of local businesses, using an adequate orientation of ACODECO and with a continuous record of attention claims. In turn, it allows its affiliates to maintain an ACODECO complaint form so consumers can present them locally without having to travel outside its locality, which represents a benefit to their clients and thus aims to raise the profile to those businesses that adopt this responsibility with their consumers.

It also seeks that the relationship of consumption between supplier and consumer not only be attached to the provisions established in Law No. 45 of consumer protection but also reflects the highest sense of commitment that a business entity should express.

Chile

To guarantee a higher quality of telecommunication services, SUBTEL implements a benchmarking instrument, *Modelo de Competencia por calidad de Servicio* (MCCS), that provides an efficient comparison between the quality of telecom services. It also enables users to make smarter buying decisions and fosters telecom competition. The general purpose of the MCSS is to develop indicators that measure the performance of service providers; MCSS is composed of two sub-indicators: a claims measure, and network quality.

The first measure is an indicator that gathers all claim for every provider and service in the country (SUBTEL collects claims on mobile phone services, mobile broadband, fixed telephony, fixed broadband, subscription television, and international phone calls). The second measure comprises a set of representative samples taken by SUBTEL, which aims to simulate clients experience on each service (SMS, mobile internet, mobile telephony), and provider. After SUBTEL takes the sample, it constructs quality indicators like successful calls rate, speed tests, and the percentage of completed SMS, among others.

Colombia

The primary entities comprising quality of services (QoS) are *Comisión de regulación de las telecomunicaciones* (CRC) and *Superintendencia de Industria y Comercio* (SIC). The former dictates the rules on telecommunication's quality and technical support on legal battles, and resolve contract problems between providers. The latter is the national competition authority, and the consumer protection authority that solves QoS complains and establishes sanctions against every provider that violates the quality standards. Besides, the ministry of telecommunications supervises and controls that telecommunications providers comply with quality requirements.

QoS in Colombia is regulated by Resolution 3067 of 2011; it establishes the quality regime that networks and services providers must comply with their users. It obligates telecom providers to send a quarterly report to the ministry of telecommunications that must contain: a complete QoS description using the metrics defined by the CRC, a summary of technology investments that will boost capacity or coverage, user's growing demand for each service, and an account of changes in networks use. Furthermore, Resolution 3067 forces telecom firms to upload in their webpage, a coverage map that adequately describes the locations where their services are available and the type of technology on those locations (i.e. GPRS,2G,3G, and 4G).

Costa Rica

SUTEL regulates the quality of telecommunication services through the Regulation of Provision and Quality of Services (2009).[40] This regulation also establishes the relationship between the quality of the telecommunication services and the price that is charged to users, with the objective to empower consumers.

In 2016, SUTEL published data on network quality for the first time and evaluated the quality using two sources of information: a survey of perception and random tests (driver test) to different services. According to the survey in 2014, the perception of satisfaction of the telecommunication services was 7.0-8.5 (scale 0-10).

Besides, on average, the operators fulfilled the minimum quality in 90% of the cases. For example, the completion of calls, SUTEL established a minimum of 70% for 2016, while the average of the operators was 96%. [41]

Ecuador

Resolution Tel-042-01 establishes the parameters to measure the quality of services and defines standard frameworks and comparable international metrics of quality. At the same time, the resolution establishes guidelines for the regulator (ARCOTEL), who must supervise that telecom providers meet all the QoS procedures that lie on the resolution.

Ecuador uses a survey method to measure provider's quality and consumer's satisfaction; the survey asks for the general perception of mobile phone's coverage, and the level of satisfaction of consumers with respect to customer services. Also, the survey requests if the payment information on bills is understandable for clients, since it must be concise and should contain clear information about discounts, taxes, pre-paid services, and unit tariffs of pack services. Arcotel designs the survey, and it is executed semiannually over a selected sample of telecommunication users.

Arcotel takes direct measures of QoS using simulation samples of mobile phone and internet services. Using that information, it measures the percentage of complete calls, and likewise frequency of call failures over 2G and 3G networks, and on distinct providers and geographical zones. Furthermore, Arcotel records the average time that a call lasts to connect, it records the quality of the call, and it measures the percentage of SMS efficiently received. Then, when Arcotel collects the data, they construct indexes that summarize and aggregate the information, to compare the performance of telecoms companies. Many of these indexes compositions follow different ITU recommendations on quality of services metrics implementation.

[40] SUTEL (2009), Reglamento de prestación y calidad de los servicios. https://sutel.go.cr/sites/default/files/normativas/reglamento_de_prestacion_y_calidad_de_los_servicios_-_version_gaceta_ndeg8.pdf

[41] SUTEL (2016). https://sutel.go.cr/sites/default/files/estadisticas_telecompequeno.pdf

Mexico

The Federal Telecommunications and Broadcasting Law mandates the IFT to measure and supervise the quality of the telecommunications and broadcasting services. The Institute must inform the evaluation results to consumers with the objective of empowering them and reducing information asymmetries.

For this purpose, the IFT publishes a framework establishing the quality parameters that the operators have to meet. The framework is based on public consultations and international best practices, including recommendations of the International Union of Telecommunications and the European Telecommunications Standards Institute.

Recently in 2017, the IFT published the guidelines that establish quality parameters to measure the performance of voice services, text messages, and mobile data, with the objective to inform the users. Also, the guidelines establish fines to the operators that do not meet the parameters or show a weak performance. Quality data can be easily accessed on the website of the Institute.

Spain

The Secretary of State for the Information Society and the Digital Agenda, as part of the MINETAD, evaluates and supervises the quality of the telecommunications services.

The regulation framework related to the quality of service is established in the Quality Order (IET/1090/2014). The order follows 5 objectives: 1) Facilitate transparency, providing relevant information on the quality of service; 2) Guarantee minimum levels of service quality and universal service; 3) Order the inclusion, by operators, of individual quality commitments in contracts with users, as well as compensation mechanisms in case of non-compliance; 4) Keep the administration informed; and 5) Ensure a secure billing process to the users.

The methodology to measure the quality is based on recommendations of the European Institute of Telecommunications Standards.

Infrastructure

Table 8: Infrastructure Plan/Strategy

Infrastructure Plan/Strategy

Country	Plan/Strategy
Chile	Plan Nacional de Infraestructura de Telecomunicaciones (PNIT)
Colombia	Código de Buenas Practicas Para el Despliegue de Redes de Comunicaciones
Costa Rica	Plan de Acción de Infraestructura de Telecomunicaciones (PAIT)
Ecuador	Ley Orgánica de Telecomunicaciones (LOT)
Mexico	Programa de Inversión en infraestructura de Transporte y Comunicación 2013-2018
Panama	Strategic Plan of Government 2015-2019, National Strategic Digital Agenda and Strategic Plan for Broadband 2022.
Spain	Plan de Innovación para el Transporte y las Infraestructuras 2017-2020

Source: National Authorities.

Panama

Panama is a pioneer in having an underground wiring strategy (sponsored by the Government of Panama since 2012) for both, the telecommunications sector and the electricity sector, with the objective of "eliminate visual and environmental impacts, increase security and improve the quality of services for customers." The implementation and deployment of the underground wiring strategy will take place in three phases and will include most of the country.

From a regulatory point of view, Law No. 15 of 2012 establishes the formation of a company created by telecommunication operators, which will pay the corresponding cost related to telecommunication services, through trust and bank loans (approximately 23 million Balboas). Also, the law introduces a 0.5% tax to finance the underground wiring system and telecommunications and pay television infrastructure (the tax excludes prepaid services).

Chile

The Chilean government in partnership with the private sector has developed the *Plan Nacional de Infraestructura de Telecomunicaciones* (PNIT), a strategic roadmap that helps the Chilean government to boost universal access programs and to foster the implementation of modern ICT services. The plan aims to improve peoples' life quality and to conduct Chile to the digital era. To comply with the digital connectedness goals of the PNIT, Chile has the *Fondo de desarrollo de las telecomunicaciones* (FDT), a financial instrument that promotes coverage of ICT services in rural zones, and low-income urban zones. Decree 353 dictates the regulation for FDT, which is a significant law as it dictates how resources for telecommunication progress are being allocated.

Apart from PNIT, which mainly comprehend government's guidelines to achieve digital connectedness and usage of ICTs in isolated locations, Chile has also rules that regulate private telecoms' infrastructure

deployment. In this sense, Decree 99 of 2012 dictates the rules for intermediate service providers that only provide physical infrastructure to final users. The decree also establishes the requirements for installing infrastructure, exploiting licenses and the right-of-way over land buildings and towers where intermediaries build physical infrastructure. Decree 99 is important as it imposes regulation's flexibility of private infrastructure deployment on Chilean cities.

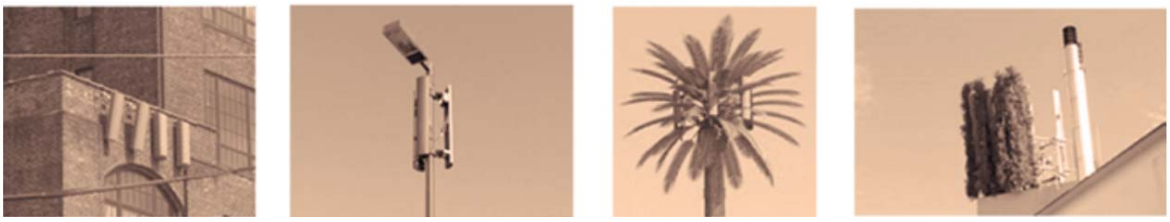
Normative modification 13 of 2011, by the market competition authority *Tribunal de Defensa de la Libre Competencia (TLD),* proposes that the government should consider incentive infrastructure sharing, instead of conferring subsidies to telecom companies which could induce market distortions like barrier entries or market abuse. Besides, there is not a precise regulation for mobile virtual networks operators (MVNO), recently there were complains of Chiles' MNVOs arguing unfair practices and asked Subtel for better regulation on MNVOs. Thus, Subtel is currently working on a regulatory framework for MNVOs.

Colombia

CRC issued the *Código de Buenas Prácticas Para el Despliegue de Redes de Comunicaciones*, which is a complete guide that aims to support and instruct local governments on telecommunication infrastructure policies. The main idea is that if regional policymakers understand the current's country legislation and international practices and recommendations, there will be smarter planning of regional telecommunications that finally will boost infrastructure deployment. The key points of this document are:

- First, to preserve people's health, the document shows international and national legislation on exposure to electromagnetic fields. It shows how people get damage for emissions associated with using high-frequency bands, and what should be the policy approach to offset the cost. Colombia's legislation on exposure to electromagnetic fields follows ITU recommendations (UIT-T K.52, UIT-T K.70, UIT-T K.83, UIT-T K.100). In this sense, the Decree 195 of 2005 established people exposure limits to electromagnetic fields and dictated norms for radio stations installation. Building an adequate regulatory framework for radio stations installations is essential for a healthy and friendly environmental infrastructure deployment.
- Second, the document present guidelines to reduce the negative impact of infrastructure construction, and recommendations to guarantee higher efficiency on the sector. One adverse effect of telecommunications infrastructure is the damage to the urban and architectonic look of the cities, CRC's recommendation on this topic involves camouflage's techniques to give a better look too distinct telecommunication building (Figure 16). Also, to reduce the adverse visual impact of infrastructure and to reduce installed costs, CRC proposed infrastructure sharing and networks interconnections following Resolution 2014 and Resolution 3101, respectively.

Figure 16: Infrastructure camouflage



Source: https://www.crcom.gov.co/recursos_user/2016/Informes/Codigo_Buenas_Practicas_2016.pdf

Costa Rica

In 2016, the MICITT published the Telecommunications Infrastructure Action Plan, which seeks to ensure telecommunication services access to all inhabitants of the country through the development of a solid telecommunication network. With this purpose, the first action was to improve the existing regulation applicable to this sector, issue a new regulation and evaluate local regulation.[42]

The law has five specific objectives: 1) Improve the existing regulatory framework, 2) The creation of a national registry of telecommunications infrastructure, 3) The deployment of infrastructure with state resources, 4) Inform the population and develop skills for public servers, and 5) Establish a mechanism to allow operators to deploy infrastructure.

Ecuador

Resolution 144 of 2017 establishes the technical norms for subterranean physical infrastructure deployment in Ecuador (optical fiber, copper telecom cables, coax, HFC, among others wired technologies). It obligates infrastructure sharing to avoid non-subterranean wired connections which produce an adverse visual impact. Furthermore, infrastructure sharing avoids discriminatory practices and market abuse by the owner of the network. Besides, Resolution 144 dictates physical characteristics that the infrastructure must fulfill, like types of materials, security standards, efficient use of the ground, low construction time, and modern design.

Apart from subterranean infrastructure regulation, LOT dictates the regulatory framework for infrastructure deployment in Ecuador. Article 105 specifies the right-of-way, in which every person that controls land or goods that are necessary for telecommunication services must allow its utilization by the telecom service providers. Article 106, establishes conditions for infrastructure sharing agreements between providers, and Article 25 obligates access and interconnection between services providers that possess physical infrastructure, and Resolution 628 establishes norms for national roaming, broadly it obligates telecoms to share their networks to extend national coverage.

[42] SUTEL (2016), Política Publica en Materia de Infraestructura de Telecomunicaciones. http://www.telecom.go.cr/images/comision_infraestructura/2016/Politica-de-Infraestructura.pdf

Mexico

The Ministry of Communications and Transportation (SCT) has the faculty to develop and establish the pipeline of projects to boost investment in infrastructure in the telecommunications sector in Mexico. In 2013, the SCT published the Investment Program in Infrastructure of Transport and Communications 2013-2018 (*Programa de Inversión en infraestructura de Transporte y Comunicación*) with the objective of establishing a guideline of strategic projects to boost the sectors of telecommunications and transportation in Mexico.

The program includes five projects to increase and improve the telecommunications infrastructure. The programs are: 1) Two communications satellites, 2) A Wholesale Shared network, 3) Increase the telecommunications backbone, 4) Transition to Digital Terrestrial Television, and 5) broadband in 80,000 public places. All of these projects are now under implementation.

Also, the IFT is in charge of the regulatory framework of access and sharing of infrastructure. The regulator promotes contracts of co-location and sharing infrastructure between operators. It also establishes the terms and price of the contracts if there is no agreement between the operators and if it is an essential input to offer the service. Moreover, it maintains an updated database of all active infrastructure and transmission mediums, passive infrastructure or rights of way, and public places.

Spain

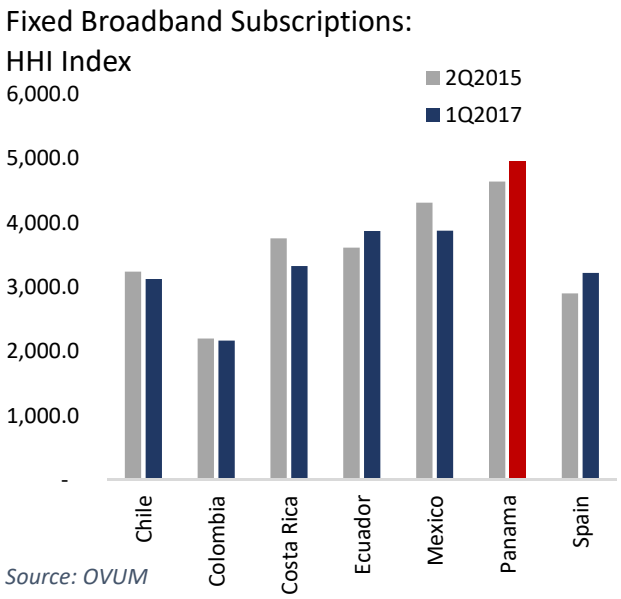
The General Telecommunications Law pursues the objective, among others, to encourage competition without discouraging investments. Article number 45 of the Law regulates the incorporation of Common Telecommunications Infrastructure and installation of final stretches of ultrafast access fixed networks in already built buildings. Also, the Ministry of Development published in 2017 an Innovation Plan for Transportation and Infrastructure, which considers the development of the telecommunications infrastructure to transform Spanish cities into Smart Cities. [43]

Currently, an essential deployment of ultra-fast networks is taking place in Spain. To facilitate the deployment of infrastructure, the Secretary of State for the Information Society and Digital Agenda elaborated a guideline for the deployment of infrastructure in the context of disputes between operators and landowners in several communities.

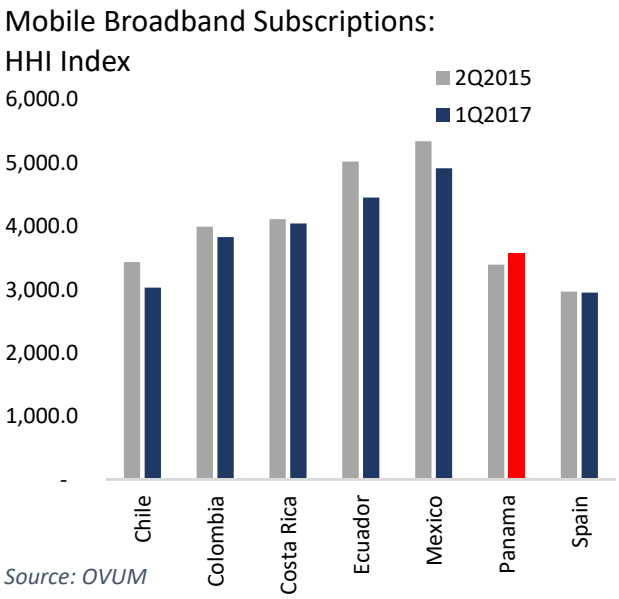
[43] Ministerio de Fomento España (2017), Plan de Innovación para el Transporte y las Infraestructuras. https://www.fomento.gob.es/NR/rdonlyres/66DE13DA-C640-4FB7-B83A-E8E9C6A2FD70/145816/2017_10_27_plan_innovacion.pdf

Measures of competition in the markets of Fixed Broadband, Mobile Broadband, and Spectrum

Figure 17, 18, 19 HHI Indexes



Source: OVUM



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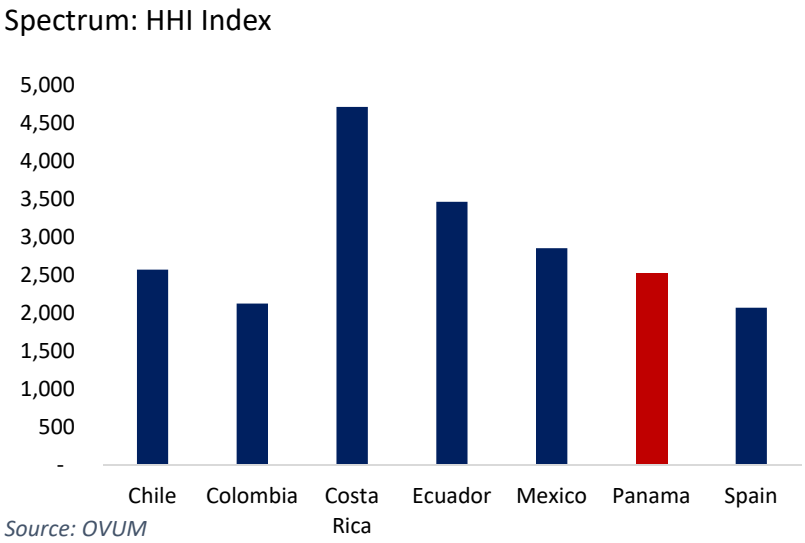


Source: OVUM

Panama

Although general and specific regulations fall under ADECO´s jurisdiction, ASEP can issue resolutions and rules intended to promote fair and efficient competition, as well as to prevent anti-competitive practices in the public services sector.

However, the favorable opinion of ACODECO is required in specific matters, such as monopolistic, anticompetitive and discriminatory practices in the provision of services. In this sense, the legal framework of the regulated sectors contemplates that the ASEP must:

- Promote competition and efficiency in public service operations to prevent possible monopolistic, anti-competitive or discriminatory behavior in the companies that operate these public services. To this end, the ASEP dictates, through resolutions, the regulations required to maintain competition that benefits public services. The ASEP can issue rules in regulated markets, with the condition of previously consulting ACODECO. The ASEP will request the favorable concept of ACODECO in the specific points of resolutions or regulations that affect possible monopolistic behavior, anti-competitive or discriminatory behavior in public services.
- Assist ACODECO in its investigations, help it gather information and knowledge and assist in the verification of possible monopolistic behavior, anti-competitive or discriminatory behavior by companies or organizations serving the public.
- Immediately forward to ACODECO a detailed report of any fact or conduct of a regulated company if the ASEP considers that it may affect competition, so that ACODECO may immediately initiate an investigation.
- Recommend that the requests for precautionary measures by the parties of ACODECO before the competent courts in the cases investigated are submitted in such a way that they can be sustained following the provisions of the Code of Justice and the legislation in force and within the framework of the competition system. Previously, some of these functions were part of the jurisdiction of sectoral regulators.

Under these rules, there exists a strong inter-institutional collaboration between ASEP and ACODECO.

In the application of the concepts of the Law on Competition, the ASEP declared that the "telecommunication networks" and the "public works that support them" in buildings, commercial properties, and other centers, constitute common and essential infrastructures for the services of telecommunication and as such they should be available to all concessionaires. In the same sense, the ASEP ordered the concessionaires to abstain from concluding contracts to any other agreement with any person whose objective is the acquisition of exclusive rights to provide services or the administration of the infrastructure with the capacity to restrict access. According to the ASEP, the declaration and the order were necessary to protect the right of access to telecommunication services and the right of consumers to choose the service provider. With this practice, the ASEP explicitly favors intra-network competition concerning the competence of the facilities.

The criteria that the ASEP must take into account to determine if an operator has a dominant position in its market are contained in Resolution No. JD1334 of April 12, 1999. Also, through the AN Resolution No.

566-Telco of January 16, 2007, the ASEP identified the concessionaires that have a dominant position for each of the 16 public telecommunications services; Wireless Cable S.A. was identified as the operator with a dominant position in nine of these services.

Figure 20, 21 Mobile Subscriptions Market Share

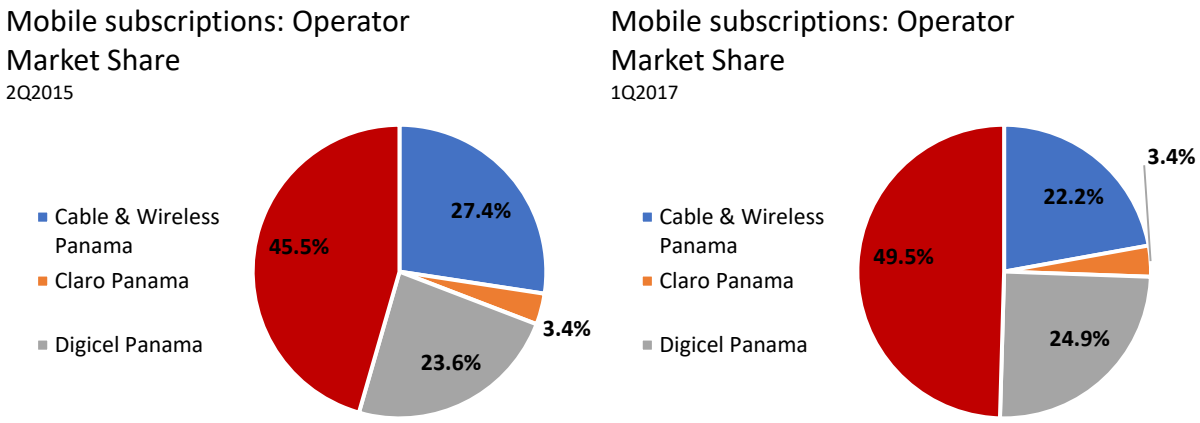
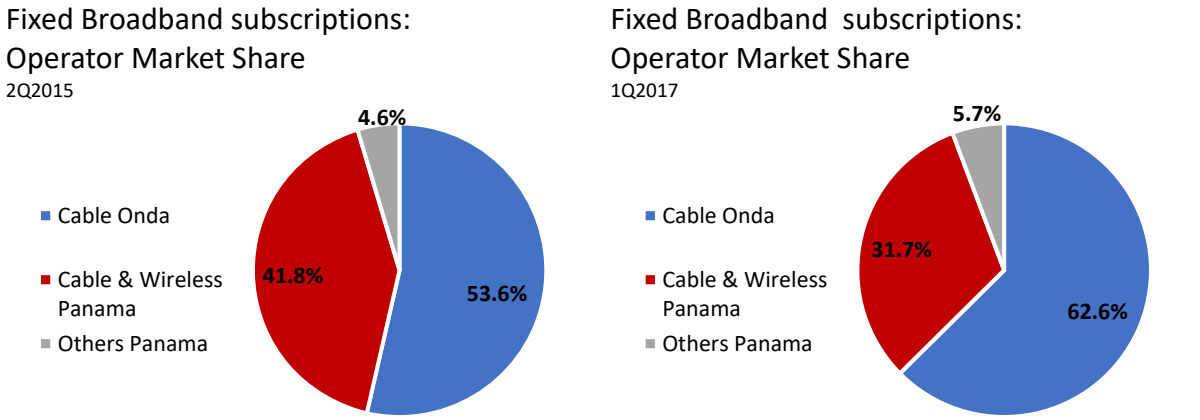


Figure 22, 23 Fixed Broadband Subscriptions Market Share



Source: OVUM.

Chile

Claro, Movistar, and Entel have been the dominant telecommunication companies in Chile. In 2015 WOM company entered on Chile's telecommunication market, it offered low prices plans to attract people that didn't have a mobile plan at the time. Among the main rules that promote competition, Law 20.471 of 2010 obligates providers to implement a portability system, which allows users to change its telecom provider by keeping their phone number. Also, Law 20.471 implementation was essential to WOM's success, as long as it has permitted several users to pick WOM as their preferred telecom

provider. This law and the fourth telecom operator has fostered competition on the market and have benefited telecom users with lower prices.

MVNOs are gaining importance on Chile's telecommunication market, in 2017 there were four MNVOs: Falabella Gtd-Movil Virgin Mobile Chile and VTR cellular. Proliferation and improvement of current MVNOs will boost competitiveness in Chile's telecommunication market, and prices will go down. However, MVNOs only represents 2% of Chile's total mobile connections, and they are too small to compete with the more prominent telecom companies. Besides, as MNVOs rent infrastructure to telecom providers, it is necessary a complete regulatory framework that prevents unfair and abusive practices, SUBTEL is currently working on it.

Colombia

Colombia regulatory authority CRC and the ministry of telecommunications MINTIC have done different policies to promote market competition. Ley 1245 of 2008, establishes the obligation to implement mobile phones' number portability which allows users to migrate from one provider to another keeping their number. Furthermore, in 2014 CRC prohibited permanence clauses in mobile telephone market, and linked tariffs to mobile phone equipment because both practices had been used to restrict user's mobility, increasing the monopolistic power of dominant providers. In the fixed communications market permanence clauses are allowed but are regulated by resolution 4930 of 2016 to minimize their negative impact on users' welfare.

CRC recently promulgated Resolution 5107 of 2017, on national roaming RAN, which enables an operator to extend coverage (2G, 3G or 4G) using the infrastructure of another operator. RAN promotes competitiveness and quality of the services. Finally, Resolution 5108 of 2017 dictates norms to Colombian MNVOs, to guarantee fair tariffs for them, lower prices for users, lower entry barriers on the market, and incentive competition.

Costa Rica

Competition rules in the telecommunication sector follow the Regulation of the Competition Regime in Telecommunications. It establishes SUTEL as the primary authority to ensure competition in the telecommunications sector. In this sense, SUTEL main functions are to promote competition, analyze the level of competition, identify when actions can affect competition, eliminate entry barriers, and eliminate monopolistic practices.

SUTEL has published three documents that serve as guidelines for competition analysis in the telecommunications sector. The methodologies contained in the guidelines follow best international practices. The first document, Guide to Analysis of Concentrations of the Telecommunications Sector, comprises information about the fundamentals of market concentrations. The second document, Anticompetitive Behavior Analysis Guide, defines and distinguish between absolute and relative monopolist practices. The third document, Guide of Market studies, is a description of market studies and how they can be used to improve competition.

Ecuador

Article 32 of *Ley General de Telecomunicaciones* (LOT) dictates the principal obligations for dominant providers. It establishes that dominant providers must set tariffs and prices that don't restrict competition in the sector and guarantee quality and affordability for final users; it also contains on-net (off-net) tariff mechanisms. Besides Article 32 obligates interconnection charges that foster free competition and lower barriers in the market; it regulates asymmetric and symmetric tariffs; and imposes an obligation on infrastructure sharing.

With the aim of avoiding market distortions on the telecommunications market Article 94 of LOT imposes an annual profit tax to every private provider that highly concentrates the market. Also, Resolution 628-20 dictates principles and guidelines for national roaming, and Resolution 627-20 establishes rules for MNVOs. However, the presence of virtual mobile operators in Ecuador is lagged comparing to another Latin America countries since only one MNVO operates in the market, Virgin Mobile.

Mexico

In cases related to telecommunications, the IFT is the competition authority, as established in the Federal Telecommunications and Broadcasting Law. However, COFECE is the authority in the rest of the sectors; in this regard, disputes between both authorities were observed, since they claimed to be the competent competition authority.[44] In the first case, the IFT was designed as the competent authority, and in the second case, both authorities work together in the case.

The IFT has several mechanisms to promote competition as the definition of preponderant agents, substantial market power (SMP) and prohibition of monopolistic practices. Using the preponderance concept, the IFT can impose asymmetrical regulation to the preponderant in telecommunications to diminishing its market power below 50%. The SMP concept is another route to impose asymmetrical regulation on companies that have SMP. This concept considers both, national and regional dimensions of relevant markets (product or location). To determine that a company has SMP various elements must be considered and are defined in the article 59 of the Federal Telecommunications and Broadcasting Law. The prohibition of monopolistic practices enables IFT to conduct investigations in matters of dominance and anti-competitive agreements. The monopolistic practices can be absolute or relative.[45] Also, IFT is the authority on matters of M&A following the objectives of the competition authority. [46]

[44] OECD (2017), OECD Telecommunications and Broadcasting Review of Mexico 2017.
[45] OECD (2017), OECD Telecommunications and Broadcasting Review of Mexico 2017.
[46] www.ift.org.mx

Spain

The CNMC, as the competition authority, has the objective of ensuring proper market functioning, through the establishment and supervision of[47] obligations imposed to operators. For this purpose, the CNMC is capable of imposing asymmetrical regulation to operators with the significant market power to ensure similar market conditions and transparency for all. Also, the CNMC settles disputes between operators and impose fines to operators that do not comply with regulations.

To ensure competition and switching costs, the CNMC promotes and supervises number portability. In November of 2017, 900,000 numbers were ported, reflecting that competition is intense in the market for telecommunications.

Consumer´s protection and empowerment

Panama

In general, ACODECO is the main authority regarding consumer´s protection and empowerment, following:

- Constitutional basis: Political Constitution of the Republic of Panama, titles III (Individual and Social Rights and Duties) and X (The National Economy).[48]
- Main legislation: Law No. 45 "That dictates Rules on Consumer Protection and Defense of Competition and Other Provisions," of 2007, which was modified by Law No. 34 of 2016.[49]
- Law No. 81, "That protects the rights of users of credit cards and other financing cards" of 2009.[50]

Nonetheless, ASEP has the obligation to control and set the guidelines for the fulfillment of the Regulation on the Rights and Duties of Users of 1997 (*Reglamento Sobre Los Derechos y Deberes de Los Usuarios*), as well as to be informed about the complaints of the deficient provision of public telecommunications services, electricity, drinking water supply and sanitary sewage (this regulation was modified by Resolutions No. JD-121 of 1997 and JD-2457 of 2000).

Chile

Decree 18 of 2014 contains consumer protection measures that aim to defend the user whenever it acquires a specific telecommunication service; it establishes rules and obligations for companies that provide fixed (mobile) telephony, pay TV, Fixed (mobile) internet, and international roaming. For the case of the fixed internet, each provider must reveal information on internet speed tests, quality of service, traffic and bandwidth measurements, among others. Likewise, for mobile telephony, the decree

[47] CNMC (2017). https://www.cnmc.es/ambitos-de-actuacion/telecomunicaciones
[48] http://www.acodeco.gob.pa/acodeco/uploads/pdf/legislacion_normativas/
[49] http://www.acodeco.gob.pa/acodeco/uploads/pdf/legislacion_normativas/
[50] http://www.acodeco.gob.pa/acodeco/uploads/pdf/legislacion_normativas/

establishes that international roaming must be blocked by default, and it only will be active when the user requires the activation.

Decree 18, obligates every provider to launch an online price comparator, that allows users to compare services, plans, and offers efficiently. Furthermore, providers must publish and inform geographic coverage on their website and current offices for each technology type. Both instruments, the price comparator, and the coverage map will improve consumer's empowerment and welfare. Moreover, the decree prohibits different bundled services prices, and the provider must show the individual cost of each service, and explicitly show if a discount is applied on the bundled (SUBTEL,2015).

Colombia

Resolution 5111 of 2017 establishes the regulatory framework for consumer protection in services like fixed (mobile) internet, fixed (mobile) telephony and postal services. Resolution 5111 also establishes free choice, quality, information, and free paperwork as the general principles of consumer protection. Free choice means that the user can choose any operator, services plan, and devices. The quality principle states that operators must provide continuous and efficient telecommunication services according to QoS standards. Information principle states that users have the right to receive precise, correct, complete and free information about the acquired services. Also, users can decide whether they want to receive the information by e-mail or postal service.

CRC has an online platform that contains the primary telecommunication users' rights. The platform increases consumer's empowerment, as it informs in a tractable and straightforward way the main topics of consumer protection. This platform includes users' rights on free choice; rules on telephone number portability; prohibition on permanence clauses on mobile telephony and conditions for fixed services permanence clauses; instructions for international roaming; coverage rights; contract modification; and billing.

Costa Rica

The Promotion of Competition and effective consumer protection (No. 7472) Law has the objective, among others, to protect consumer rights and their interests. The National Commission of Consumer is in charge of the effective protection of the consumer in all sectors. In the case of the telecommunications services, SUTEL is also capable of resolving conflicts between users and operators, regarding the violation of users rights established in the General Law of Telecommunications.

For this purpose, the CNC has an online platform where the users can present their claims against telecom providers. SUTEL offers another mechanism: first, the user should try to solve the conflict directly with the provider; then, if the conflict persists, the user can ask help to SUTEL, who will solve the

claim. The complete and detailed process is described in *the Guide to present a claim before SUTEL* published in SUTEL´s web site.[51]

Ecuador

Ley Orgánica de Defensa del Consumidor is the law that regulates consumer´s protection for all the Ecuadorian economy. It contains consumers' general rights and obligations, advertising rules, goods and services information, warranties procedure, billing, technical service, contract design, sales and discounts, quality control, sanctions, among others. Apart from this general law that regulates consumer´s protection, *Ley Orgánica de Telecomunicaciones* (LOT) specifies rules for consumer´s protection in the telecommunication sector.

In this sense, Article 22 of LOT establishes user's free choice of operators and plans, and the right to have access to concise, correct and free information about tariffs. The same article prohibits any rounded methods on billing and allows for electronic billing service. Furthermore, to empower consumers, article 22 establishes the guidelines to settle mobile phone number portability disputes and prohibits blocking, censoring, banning, or limiting any legal application website or internet service.

Mexico

The consumer´s protection authority is PROFECO and the IFT. The users of telecommunications services can submit complaints against the operators in the case that the contractual obligations were violated to both authorities. Thus, both institutions cooperate to ensure users protection. PROFECO protects the user´s rights while IFT ensures the compliance of minimum quality of service and provides technical advice and information.

A General Collaboration Framework Agreement was signed by both institutions, aims to establish the basis for the collaboration to protect the consumer rights. Besides, both authorities share information with the objective to facilitating their others functions (for example competition). As an example of joined actions, PROFECO created an online dispute-resolution platform (Conciliated) to facilitate the process in the telecommunications services.[52]

Spain

In 2004, the Telecommunications User Service Office was created (by the Royal Decree 1554/2004) to establish specific mechanisms to user services and efficient systems to resolve claims. In this context, the OAUT have two functions: 1) resolve disputes between telecommunications users and operators, and 2) inform customers about their rights.

[51] SUTEL (2014) Guía para presentación de reclamaciones ante la SUTEL. http://sutel.go.cr/sites/default/files/guia_para_la_presentacion_de_reclamaciones_ante_sutel_0.pdf
[52] OECD (2017), OECD Telecommunications and Broadcasting Review of Mexico 2017.

Claims about the services can be made on the website of the OATU (http://www.usuariosteleco.gob.es) and by telephone. All the process can be completed online. In this regard, the OATU publishes data about the result of claims and keeps a record of each operator. In 2016, 71% of all claims results were in favor of the users. Besides, Chapter V of the General Law of Telecommunications establishes user´s rights in the context of telecommunication networks and services. The OATU also publishes a simplified version that can easily be reached and understood by the users. [53]

Network Neutrality Big Data, Artificial Intelligence, and IoT.

Panama

Autoridad Nacional de Transparencia y Acceso a la Informacion (ANTAI) prepared a law draft to regulate data protection. It will dictate general norms for data storage and data collecting processes, which aims to guarantee higher security standards for critical data and privacy-preserving protocols that maintain individual's anonymity. The law is the first step to constitute a data ecosystem in the country, since to developed big data, IoT and artificial intelligence practices it is necessary to draw the boundaries of data privacy.

Chile

Law 20.453 of 2010 establishes the principle of network neutrality in Chile. The law prohibits internet providers (IPS) to obstruct, deny, or blocked users internet navigation or to limit media content. Therefore, IPS must guarantee internet access without incurring on an arbitrary selection of media content, applications, and internet services; it can only block online contents when; the content is illegal, there is parental control, or the content damaged the network. Chile was one of the first countries in the world on the implementation of the network neutrality principle.

Chile does not have a specific Big Data's regulatory framework. However, law 19.628 establishes a framework for personal data treatment, data privacy, data storage, data transmission, sensitive data, data accessibility, a data register, and data owners. Hence, Law 19.628 serves as the first stage of a regulatory framework for Big Data.

Finally, in Chile, there is not a regulatory framework for IoT neither for Machine to Machine devices (M2M), which is a technology that goes beyond countries laws. However, in a recent survey, the sub-secretary of telecommunications revealed that they are working on regulation for IoT, which involves the design of rules for IoT implementation and operation, and a spectrum band allocation for its functionality. Also, there has been prototypes, experiments, and seminars that aim to developed smart cities in Chile, a situation that finally will accelerate the design of a regulatory framework in this matter.

[53] http://www.usuariosteleco.gob.es/

Colombia

Plan Nacional de Desarrollo (PND) 2014-2018 is the essential roadmap for Colombian government that dictates the goals for fundamental issues like, economic growth, poverty reduction, education, infrastructure investments, social mobility, rural policy, security, justice, democracy, among others. It is the first PND in Colombian history that highlights the importance of big data implementation on the developed of innovation policy based on data analysis and using big data as a planning tool for large administrative records. However, there's still a long way to go, a recent survey conducted by Colombian national planning department shows that only 3.3% entities are in condition to consistently implement big data. The main reasons are low digitalization levels, persistence on the usage of paper, limited data anonymization, low usage of unstructured data, many barriers across entities data sharing, among others.

Resolution 3503 of 2011, establishes network neutrality in Colombia. The resolution dictates four main principles that characterize network neutrality in Colombia: free choice, no discrimination, transparency, and information. The first one establishes that the user can freely utilize, send, receive or offer any content or application through the internet. The second principle establishes that internet providers (IPS) must give equal treatment to all internet applications without any form of discrimination; the third one dictates that IPS must reveal their bandwidth policies; the fourth one establishes that IPS must provide detailed information about their services quality.

Finally, Colombia leads Latin America in developing a proper regulatory framework for IoT. *Agencia Nacional del Espectro* (ANE) is planning to assign 50 MHz of spectrum for IoT use, which will create a favorable environment for IoT development (Badgujar, 2017). Furthermore, CRC has been studying the implementation of a complete IoT regulatory framework. Nevertheless, IoT is intensive in ICT infrastructure. Hence Colombia still needs to improve connectivity, penetration and average velocity to implement IoT efficiently.

Costa Rica

Costa Rican laws do not define the concept of network neutrality explicitly. However, the principle of the General Telecommunications Law include some concepts implicitly about network neutrality and SUTEL applied the concept in guidelines and regulations. One of the main objectives of the Law, article 2 d), is about the protection of user's right to get access to information technologies ensuring efficiency, equality, continuity, quality, as guaranteed privacy and confidentiality. Those principles are directly related to the concept of network neutrality. A main principle of the Law, article 3 c), is about benefits from the users, such as access to communication services in conditions of equality and non-discrimination. Furthermore, SUTEL includes the concept of network neutrality in regulations including the determination of parameters that guaranteed users rights. [54]

[54] SUTEL (2017). "Determinación de los parámetros que garanticen el usuario final el derecho de información y el acceso funcional al del servicio de internet móvil".

Ecuador

Article 13 of LOT entails that Ecuador must foster network neutrality. However, there have been critiques of network neutrality implementation in Ecuador, since it has been argued that unequal treatment to some applications has been observed and there are not a clear and complete ARCOTEL's regulation on network neutrality.

Regarding IoT and Big Data, ARCOTEL and the government have recognized their importance (Ecuador's digital Agenda 2016-2021) in current trends and the future of telecommunications. However, there is not an independent regulatory framework about it.

Mexico

The General Law of Telecommunications in its article 145 establishes that operators must provide internet access services according to general guidelines of consumer choice and non-discrimination. However, the IFT had not published nor defined the general guidelines that shall be applied. The legal framework will be a matter of public consultation and examination in 2018.

Spain

The MINETAD recently published a National Plan for Smart Territories, which aims to develop new technologies in areas as Intelligent Tourism, Cities objects, 5G, smart rural territories and online platforms for public services. The objective is to introduce new technologies as big data, internet of things and artificial intelligence to improve public services. The plan includes the elaboration of a general regulatory framework and a series of pilot programs to develop new technologies. [55]

In December 2017, the minister of Information Society and Digital Agenda designed a group of experts that will analyze the social, legal, ethical implications of the use of artificial intelligence and big data in private and public sectors. This is the first effort of the authority to generate a regulatory framework for the use of advanced technologies as artificial intelligence, big data, machine learning and internet of things. The diagnostic and conclusions will be published in a White Book of Artificial Intelligence. The results will help the executive to generate a regulatory framework and a guideline of good practices in the field. [56]

[55] MINETAD (2017), Plan Nacional de Territorios Inteligentes. http://www.agendadigital.gob.es/agenda-digital/noticias/Documents/PNTI/plan-nacional-territorios-inteligentes.pdf

[56] MINETAD (2017). http://www.minetad.gob.es/es-es/gabineteprensa/notasprensa/2017/documents/171114%20np%20gt%20inteligencia%20artificial%20y%20big%20data.pdf

Gaps and Map to Improve the Regulatory Environment

Regulatory differences and ICTs policies

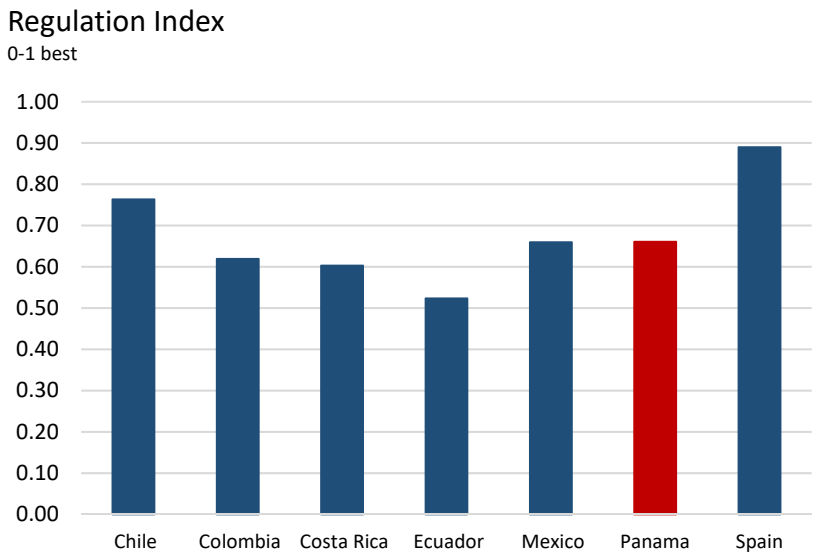
Regulation Index

To compare the regulatory framework of the selected countries, a Regulation Index is computed. The index is based on the methodology and data from the Networked Readiness Index 2016 of the World Economic Forum[57]. Also, data from World Bank and National Authorities is added to the purpose of this analysis.

The Index comprises eight groups and 21 indicators from the period 2011 to 2017. The index is computed as a weighted average of the average from 2011 to 2014 of the value of the indicators (except for Spectrum assigned and Investment in Telecoms, which are values from 2017 and 2016, respectively). Every group as the same weight in the Index and every indicator as the same weight inside the corresponding group. To make this aggregation possible, the value of the indicators were transformed into a 0 to 1 scale using a min-max transformation.[58]

According to the Regulation Index, Panama is ranked third in the overall Index. The main gaps from Panama come from the Regulation Authorities and Spectrum Authorities. In specific, Panama's performance is weak compared with other countries in the effectiveness of its lawmaking bodies, its judicial independence and the amount of spectrum allocated.

Figure 24 Regulation Index



[57] WEF (2016), Networked Readiness Index 2016.

[58] Formally, Value= Indicator/SampleMaximum, for indicators for which less is a better outcome the formula is Value= (Indicator-SampleMinimum)/ (SampleMaximum-SampleMinimum)+1

Table 9: Regulatory Index

Group/Indicator	Weight	Chile	Colombia	Costa Rica	Ecuador	Mexico	Panama	Spain
Regulation Index	**100.0%**	**0.76 (2)**	**0.62 (5)**	**0.60 (6)**	**0.52 (7)**	**0.66 (4)**	**0.66 (3)**	**0.89 (1)**
Regulatory Authorities	**12.5%**	**0.99 (1)**	**0.63 (7)**	**0.79 (3)**	**0.65 (5)**	**0.71 (4)**	**0.63 (6)**	**0.84 (2)**
Effectiveness of law-making bodies, 1-7	6.3%	0.97 (2)	0.71 (6)	0.62 (7)	0.79 (3)	0.79 (4)	0.75 (5)	1.00 (1)
Judicial independence, 1-7 (best)	6.3%	1.00 (1)	0.55 (5)	0.96 (2)	0.51 (7)	0.63 (4)	0.52 (6)	0.67 (3)
General Regulation Framework	**12.5%**	**0.87 (2)**	**0.66 (5)**	**0.61 (6)**	**0.45 (7)**	**0.80 (3)**	**0.90 (1)**	**0.70 (4)**
Laws relating to ICTs, 1-7 (best)	1.8%	0.99 (2)	0.89 (5)	0.90 (4)	0.86 (6)	0.86 (7)	0.97 (3)	1.00 (1)
Efficiency of legal system in settling disputes,	1.8%	1.00 (1)	0.75 (5)	0.84 (2)	0.73 (7)	0.74 (6)	0.82 (3)	0.79 (4)
Efficiency of legal system in challenging regs,	1.8%	1.00 (1)	0.75 (6)	0.99 (2)	0.62 (7)	0.76 (5)	0.82 (3)	0.82 (4)
No. procedures to enforce a contract	1.8%	0.50 (3)	0.83 (2)	0.00 (6)	0.13 (5)	0.35 (4)	1.00 (1)	0.00 (6)
No. days to enforce a contract	1.8%	0.90 (2)	0.00 (7)	0.49 (6)	0.78 (4)	1.00 (1)	0.67 (5)	0.87 (3)
No. days to start a business	1.8%	1.00 (1)	0.86 (4)	0.61 (6)	0.00 (7)	0.99 (3)	0.99 (2)	0.76 (5)
No. procedures to start a business	1.8%	0.73 (3)	0.56 (5)	0.47 (6)	0.00 (7)	0.87 (2)	1.00 (1)	0.64 (4)
Spectrum Regulation	**12.5%**	**0.64 (2)**	**0.58 (3)**	**0.49 (5)**	**0.23 (7)**	**0.55 (4)**	**0.28 (6)**	**1.00 (1)**
Spectrum allocated (MHz)	12.5%	0.64 (2)	0.58 (3)	0.49 (5)	0.23 (7)	0.55 (4)	0.28 (6)	1.00 (1)
Investment	**12.5%**	**0.51 (5)**	**0.53 (4)**	**0.31 (7)**	**0.42 (6)**	**0.68 (2)**	**0.53 (3)**	**0.83 (1)**
Venture capital availability, 1-7 (best)	6.3%	0.88 (2)	0.70 (5)	0.60 (7)	0.74 (3)	0.70 (4)	1.00 (1)	0.65 (6)
Investment in telecoms (USD millions)	6.3%	0.15 (4)	0.36 (3)	0.02 (7)	0.10 (5)	0.67 (2)	0.06 (6)	1.00 (1)
New Regulation	**12.5%**	**0.93 (2)**	**0.81 (7)**	**0.83 (4)**	**0.83 (6)**	**0.83 (5)**	**1.00 (1)**	**0.86 (3)**
Availability of latest technologies, 1-7	6.3%	1.00 (1)	0.79 (7)	0.89 (4)	0.80 (6)	0.87 (5)	0.99 (2)	0.99 (3)
Gov't procurement of advanced tech	6.3%	0.85 (2)	0.84 (4)	0.78 (6)	0.85 (3)	0.79 (5)	1.00 (1)	0.74 (7)
Access and quality	**12.5%**	**0.67 (2)**	**0.60 (5)**	**0.60 (4)**	**0.53 (6)**	**0.50 (7)**	**0.61 (3)**	**0.90 (1)**
Mobile network coverage, % pop.	4.2%	0.97 (4)	1.00 (1)	0.80 (7)	0.96 (5)	1.00 (2)	0.96 (6)	1.00 (3)
Int'l Internet bandwidth, kb/s per user	4.2%	0.56 (2)	0.44 (5)	0.51 (4)	0.34 (6)	0.20 (7)	0.53 (3)	0.98 (1)
Households w/ Internet access, %	4.2%	0.50 (3)	0.35 (4)	0.50 (2)	0.27 (7)	0.30 (6)	0.35 (5)	0.71 (1)
Infrastructure	**12.5%**	**0.49 (2)**	**0.17 (6)**	**0.33 (4)**	**0.16 (7)**	**0.25 (5)**	**0.37 (3)**	**1.00 (1)**
Electricity production, kWh/capita	6.3%	0.64 (2)	0.21 (7)	0.34 (5)	0.23 (6)	0.39 (3)	0.35 (4)	1.00 (1)
Secure Internet servers/million pop.	6.3%	0.34 (3)	0.12 (5)	0.31 (4)	0.10 (7)	0.10 (6)	0.39 (2)	1.00 (1)
Competition	**12.5%**	**1.00 (2)**	**0.97 (3)**	**0.86 (7)**	**0.93 (6)**	**0.96 (5)**	**0.96 (4)**	**1.00 (1)**
Intensity of local competition, 1-7	6.3%	1.00 (2)	0.95 (3)	0.94 (4)	0.86 (7)	0.93 (6)	0.93 (5)	1.00 (1)
Internet & telephony competition, 0–2	6.3%	1.00 (1)	1.00 (1)	0.78 (7)	1.00 (1)	1.00 (1)	1.00 (1)	1.00 (1)

Source: own calculations with data from WEF, WB, ITU and National authorities.

Bottlenecks and areas of opportunity

The first part of the document aims to provide a detailed map of the private and public sector agents in Panama´s telecommunication sector. This section provides an analytic framework to identify the regulatory and market environment deficiencies. In this sense, we divide the analysis into two parts: (i) the regulatory areas of opportunity identified by studying Panama´s law and programs in telecommunications and digital adoption, and (ii) using a new regulatory index, we match the regulatory deficiencies with key indicators in Panama´s telecommunications sector.

In general terms, from both, analytic and legal analysis, we identify the following regulatory deficiencies in Panama´s legal framework that act as barriers to the sector development and inclusion of ICTs in Panama:

1. Unclear division of faculties between the principal agencies that regulate the telecommunications sector, mainly in competition, M&A and consumer´s protection and empowerment.
2. Specific programs and plans for infrastructure deployment have not been developed in the country, for both mobile and fixed communications.
3. Identification, liberalization, and allocation of additional spectrum bands for IMT services need to be put in place.
4. Additional programs and tax incentives to boost foreign and private investment are needed.
5. Lack of regional and focalized policies to reduce the inequality of access to broadband and Internet.

The above list of bottlenecks is described next. Regarding competition, ADECO is the principal authority with the faculties to issue resolutions and rules to promote fair and efficient competition and to prevent anti-competitive practices, as well as to define the fines and sanctions in case anticompetitive practices are identified. Nonetheless, in the telecommunications sector, the ASEP plays a central role in the promotion of competition, since it assists ADECO in the investigations and can issue new regulation but always with ADECO´s approval. This interaction between agencies hinders and delay the development and implementation of rules and regulation to prevent anticompetitive practices, mostly in a sector that is constantly changing, evolving and innovating at an accelerated pace. This is mainly due to the level of technical knowledge (technified industries and society) of the sector and to the fact that the response time is extended due to the administrative coordination between two agencies. Also, in an environment that is constantly evolving, the know-how and expertise to issue flexible regulation and rules to promote competition are always on the side of the telecommunication´s regulator; therefore, this process will be behind the needs of the market, slowing down the development of a telecommunications sector with full competition.

Something similar occurs regarding M&A regulation in Panama since concentrations are governed by the terms of the concession agreement according to Chapter V of Law No. 31 of 1996, the main law of telecommunications but ACODECO makes the final decision to approve M&A transactions.

In addition to the deficiencies in competition and M&A regulation in Panama, the rules related to consumer´s protection and empowerment also contain parallel faculties between ADECO and ASEP. The former is entitled to protect the rights of users, and the later must set the guidelines for the fulfillment of the regulation on the rights and duties of users and inform about the complaints of the deficient provision of telecommunications services, among others services. In this sense, technified knowledge, channels of communication with service providers, and information about consumer´s preferences and needs are on the side of the regulator of telecommunications. Therefore, even with the existence of specific guidelines for the protection and empowerment of consumers, its application shows administrative and compliance bottlenecks.

The above deficiencies can be solved by redefinition of faculties between agencies, giving ASEP more capacities in competition, M&A and consumer´s protection and empowerment. The parallelism between agencies capabilities and law enforcement in these topics have led to a highly concentrated market and services with low velocities. For example, the concentration in broadband for mobile and fixed services in Panama is high, since

Besides these regulatory bottlenecks, Panama shows two additional issues concerning essential inputs in the telecommunications, digital markets, spectrum allocation, and infrastructure deployment.

Although, Panama has implemented measures to allocate more spectrum to the market for IMT services, like the liberalization of the 700 MHz band through the digital switch-over and the inclusion of the 2.5 GHz band in the PNAF, it is well behind in assigned spectrum with respect to several comparable countries (i.e. Mexico, Colombia and Chile) and the OECD average. This situation is mainly due to the lack of programs to identify more spectrum bands for IMT services (for example, Mexico is working in the liberalization and re-farming of the 600 MHz band, the so-called second digital dividend, and has identified bands above one GHz, like 1,427 – 1,528 MHz, and 3,400 – 3,500 MHz).

For infrastructure deployment, Panama has worked in the deployment of underground wiring, where private telecommunications operators contribute with funds through a mandatory tax. Nonetheless, to our knowledge, specific and targeted infrastructure deployment plans or programs are not specified in any law or national agenda. In this sense, without guidelines that identify the bottlenecks for infrastructure deployment and provide a clear division of faculties between agencies, investment in infrastructure will remain static, generating barriers for the development of cutting-edge and high capacity networks.

As a result, Panama penetration levels – fixed, mobile and Internet – are below the OECD average and other comparable countries (see methodology in Volume 1). Not only that, the deficiencies in the regulation environment described above together with a reduced number of infrastructure and spectrum policies have delay private and foreign investment growth in the sector. It is worth noting that the level of investment would be lower if Panama authorities would not establish tax incentives in the Law for new incoming investments. In this sense, key indicators match the current environment in Panama; for example:

- The percentage of households with Internet access is 42%, mobile broadband penetration is 77%, and fixed penetration is 32%.

- The number of ICT contracts is below other countries and has not shown a continuous positive growth trend.
- Panama ranked 41 in infrastructure in 2016, according to the Broadband Development Index of the IDB.
- According to the most recent information, and besides Panama´s improvement during the past years, the country ranks 55 in the Network Readiness Index del World Economic Forum.

Moreover, universal access funds and mechanisms to deploy more underground wiring are not enough to increase the penetration of telecommunications. This is mainly due to the lack of targeted and regional policies in Panama, which have large inequalities and digital gaps regarding access and adoption of ICTs. This situation was correctly assessed by ASEP since they identified large penetration gaps in comparison to the most developed countries and within its borders. In the latter case, only 287 of the 634 municipalities (*or corregimientos*) in Panama have broadband access, so connectivity plans should focus on that 55% of localities. However, large-scale programs to promote access and investment in infrastructure have not been put in place yet.

Regarding adoption, Panama is one of the country leaders in comparison to digital programs and ICT adoptions. The impact on productivity, growth and social welfare of these policies is highly dependent on the regulatory environment, broadband and internet access and socio-demographics. Consequently, from the bottlenecks in competition, investment, infrastructure, access and spectrum allocation, we can conclude that the impact of digital policies will not be as deep as it could be under a more dynamic and robust environment.

This conclusion completely matches with the regulatory-digital index proposed and described at the beginning of this section. According to the general index and sub-indices, Panama red-flags are concerning regulatory authorities (effectiveness in law making and judicial independence low ranking is caused mainly by the parallel faculties between ASEP and ADECO), competition and spectrum regulation. The table also shows that Panama has areas of opportunity: in access and quality, investment and infrastructure deployment. Finally, as we mentioned before, and is also reflected in the index, Panama´s general regulation in telecommunications and adoption of ICTs (through the availability of latest technologies and digital programs) are above comparable countries.

These results provide a precise assessment to improve Panama´s immersion in ICTs and to boost the telecommunications sector with regional and focalized policies under a new legal framework.

Policy recommendations and ideal action plan

This section provides a detailed map to improve the regulatory environment in Panama to bolster its telecommunications sector and close the identified gaps. First, a brief summary of the bottlenecks found in the last section is presented, together with a robustness check using principal components analysis. Second, this section describes, for each bottleneck, success cases and the impact that some measures could have in Panama´s telecommunications sector. Finally, a list of policies – strategic action plan- to contribute to planning capacity of authorities is presented at the end of the chapter.

Bottlenecks

The past section of this volume presented a Regulation Index. To assess the validity of this index, a Principal Components Analysis (PCA) is performed (see Appendix A). The PCA shows that the regulatory environment of the sampled countries (used in the construction of the Regulation Index) is mainly explained by infrastructure, regulatory authorities and access and quality. Therefore, the Regulation Index correctly reflects the opportunity areas in Panama´s telecommunications sector.

Using the Index, as well as the evidence collected from the last section, the key areas in which Panama can improve are:

- Competition: high prices, low investment, and quality
- Spectrum: high costs, low penetration, and quality
- Investment: entry barriers
- Inequality: low immersion of ICTs

These key areas have metrics which directly reflect the possible gaps between Panama and other countries. For example, the lack of competition can be related to high prices to the users. The lack of spectrum allocation and its high cost is related to low penetration, investment, and speed. Also, inequality of access between different regions in Panama is related to the low impact that digital policies have had in the country.

In this context, and given the digital environment, Panama´s authorities should work in holistic policies and regulatory changes, since some of the main bottlenecks are related to access barriers for the new entrants, others are related to the backbone – the highway – in which data traffic of new businesses and digital platforms will circulate, and others are related to the alphabetization and immersion of ICTs to Panama´s population.

Thus, regulatory changes by themselves are not enough, digital strategies without connectivity are not enough and vice versa. Having this in mind, the next subsection analyzes, individually, policies that have helped to eliminate bottlenecks in the sector of several countries. However, a more detailed plan of action and policies are presented at the end of this section, considering that most of them should be implemented at the same time of very close one to another.

Economic Analysis

This subsection briefly summaries the main gaps in Panama´s telecommunications sector along with success cases, in which policies implemented by public authorities in several countries mitigated ,and/or eliminated barriers that impeded the development of ICTs.

Competition

Panama

Low penetration of telecommunications and services, as well as highly concentrated markets, in Panama, are mainly due to legal restrictions to participate in the sector and with the doubled window between the ASEP (regulatory authority) and ACODECO (competition authority).

As mentioned in Volume 1, Panama has used to grant concessions which bundle the rights to offer telecommunication services and the use of certain segments of spectrum. These practices deviate from best practices around the world.

From a legal perspective, these practices appeared since 1996 with the liberalization of the telecommunication sector in Panama. According to the article 19 of the Law No. 31, the concession to offer telecommunication services include: 1) The construction or use of a telecommunication network by the concessionary; and 2) the use of a certain segment spectrum, which only will be granted for the same period and subject to the same conditions as the concession to offer telecommunication services. Thus, the in order to follow the best practices, this law has to be reformed. Below, the main article that has to be changed.

> *"La prestación de servicio de telecomunicaciones conllevará, según corresponda y de acuerdo a los términos contenidos en el respectivo contrato de concesión, lo siguiente:*
>
> > *1) La construcción de redes de telecomunicaciones por el concesionario, o el uso de las instalaciones necesarias para la buena prestación del servicio concedido, las cuales se podrán contratar con terceros;*
> >
> > *2) El uso de frecuencias radioeléctricas para la adecuada prestación del servicio de telecomunicaciones concedido, el cuál solo podrá otorgarse por el mismo término y sujeto a las condiciones de la concesión del servicio de telecomunicaciones a que estén afectas."*

In consequence, the contracts between the State and mobile operators have been negotiated for the two rights. Those contracts are signed for a 20 year period. In order to follow better practices, changes to contracts have to be made.

Operator	Date	Extract of contract
Telefonica Moviles Panama	27/March/2014	*"La concesión abarca el derecho de uso exclusivo de las frecuencias comprendidas en los segmentos asignados y la prestación del Servicio de Telefonía Móvil Celular, como mínimo en las modalidades de contrato, prepago, …"*
Digicel Panama	27/May/2008	*"La concesión abarca el derecho de uso exclusivo de las frecuencias comprendidas en el segmento asignado y la prestación del servicio de comunicaciones personales (PCS) como mínimo en las modalidades …"*
Cable & Wireless	22/November/2013	*"La Concesión abarca el derecho de uso exclusivo de las frecuencias comprendidas en los segmentos asignados y la prestación de los Servicios de Telefonía Móvil Celular,..."*

Also, Panama´s current legal framework establishes a double window between the two regulatory bodies, ASEP and ACODECO. Moreover, is the later who has the attributions to impose asymmetric regulation, fines, and other measures to correct anti-competitive practices in the sector, whereas ASEP almost only function is to provide a non-binding opinion.

As a result of the double window and entrance barriers, Panama has shown concentrated markets, low penetration, high prices and low quality of telecommunication services. The following countries have implemented deep changes and policies to improve the competitive environment in the sector.

Mexico

Since the 2013 Reform, Mexico has strengthened the regulatory framework for the telecommunication sector. One of the main breakthroughs of the reform was the creation of two autonomous bodies with separate faculties regarding competition regulation: The Federal Telecommunications Institute (IFT) and Federal Economic Competition Commission (*Comisión Federal de Competencia Económica, COFECE*). Both bodies are free from political influence, whose public servants are nominated according to transparent procedures with fixed terms to deploy their functions. The reform clearly divides the faculties of the competition authorities. COFECE is the competition authority in all sector in the market, except telecommunication and broadcasting, Whereas IFT is the unique competition authority in the telecommunication and broadcasting sector. In the case of jurisdictional dispute, a designated tribunal will decide.

The Reform improved the process of decision making by allowing the IFT to no longer need the approval from the ministry of telecommunications. IFT has the faculty to determine dominant operators or operators with significant market power in the telecommunication sector, moreover can impose asymmetric regulation on those operators to ensure free competition. In addition, IFT can impose sanctions and administrative fines on operators violating the law, and to grant, revoke or reform spectrum concessions. Furthermore, the IFT has to provide transparent information about its decisions and sanctions, and the decision-making process.

Table 10: Mexico's' main telecommunication laws

Ley de Federal de Competencia Economica	
IFT responsibilities	Art. 5
COFECE autonomy	Art. 10
COFECE responsibilities	Art. 12
Ley de Federal de Telecomunicaciones y Radiodifusion	
IFT autonomy	Art. 7
IFT autonomy	Art. 8
IFT and COFECE Co-operation	Art. 264
Interconnection regulation	Art. 125
Interconnection with preponderant agents	Art. 131
Determination of SMP	Art. 59

Spain

In Spain, there is one competition authority for all sectors since 2013. The National Commission on Markets and Competition (CNMC) is the result of merging former regulatory entities (Energy, Telecommunications market, Postal Sector, Audiovisual media and Railway and airport regulation).[59] Its primary objective is to promote competition and proper function of all markets. In the telecommunications sector, the CNMC functioning is based on the regulation of the European Union.[60] In particular, the commission functions in the telecommunications sector include the definition of the competition level and imposition of obligations to operators with significant market power. The Commission was created by the Law 3/2013 and the specific attributions on telecommunication sector are stated in Law 9/2014. [61]

Table 11: Mexico's competition laws

Ley de Telecomunicaciones 9/2014	
Commission	Art. 70
Ley general de Competencia 3/2013	
Competition in telecom	Art. 6

An econometric model of competition

Wei Li and Lixin Colin Xu (2004)[62] estimate the impact of privatization and competition on Fixed-Line and Mobile penetration using a Fixed-Effects regression framework. They use data from 1990 to 2001 for 177 countries. The main results are:

[59] https://www.cnmc.es/
[60] https://ec.europa.eu/digital-single-market/en
[61] https://www.boe.es/boe/dias/2013/06/05/pdfs/BOE-A-2013-5940.pdf
[62] Li, Wei, and Lixin Colin Xu. "The Impact of Privatization and Competition in the Telecommunications Sector around the World." *The Journal of Law & Economics* 47, no. 2 (2004): 395-430. doi:10.1086/422984.

- A transition to full privatization from total or partial state ownership would increase fixed-line penetration (measured as the number of lines per 100 habitants) by 26.4% and mobile penetration by 46.7%.
- An increase in a competition index[63] by one is associated with a 39.1% increase in mobile penetration, controlling for the effects of privatization.

Following the framework set up by Wei Li, we estimated the impact of competition in fixed broadband and mobile broadband penetration. We use data from 2008 to 2017 for 29 countries. The sources of data were GSMA, OVUM, ITU and World Bank.

Table 12: Econometric model variables

Indicator	Description	Variable	Source
Mobile broadband penetration*	Unique subscribers: Total mobile internet unique subscribers at the end of the period, expressed as a percentage share of the total market population.	mbpenu	GSMA
	Connections: Mobile broadband connections at the end of the period, expressed as a percentage share of the total market population.	mbpenh	
Mobile broadband HHI (0,10000=monopoly)	Calculated based on market share of subscriptions in the country (%)	mbhhi	OVUM
Population	The population at the end of the year (million)	pops	WB
Urban population	urban population as % of total population	popsu	WB
GDP per capita	2010 USD dollars (thousands)	gdppc	WB
Fixed broadband penetration	Subscriptions per household	penfb	OVUM
Fixed broadband HHI	Calculated based on market share of subscriptions in the country (%)	fbhhi	OVUM

*Subscribers differ from connections such that a unique user can have multiple connections.

Results:

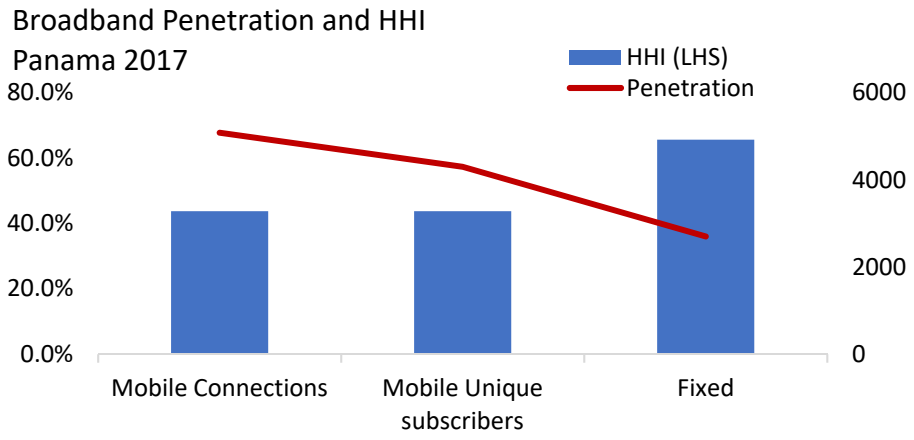
- A 1% decrease in mobile broadband HHI is associated with 1% increase in mobile broadband penetration (connections).
    - In the context of Panama's actual market. If Panama achieves to improve competition to the same level as the best of the comparable countries (Chile), the HHI index will decrease by 12%, and the mobile broadband penetration will increase 8 percentage points.
- A 1% decrease in mobile broadband HHI is associated with 0.24% increase in mobile broadband penetration (unique subscriber).
    - In the context of Panama's actual market. If Panama achieves to improve competition to the same level as the best of the comparable countries (Chile), the HHI index will

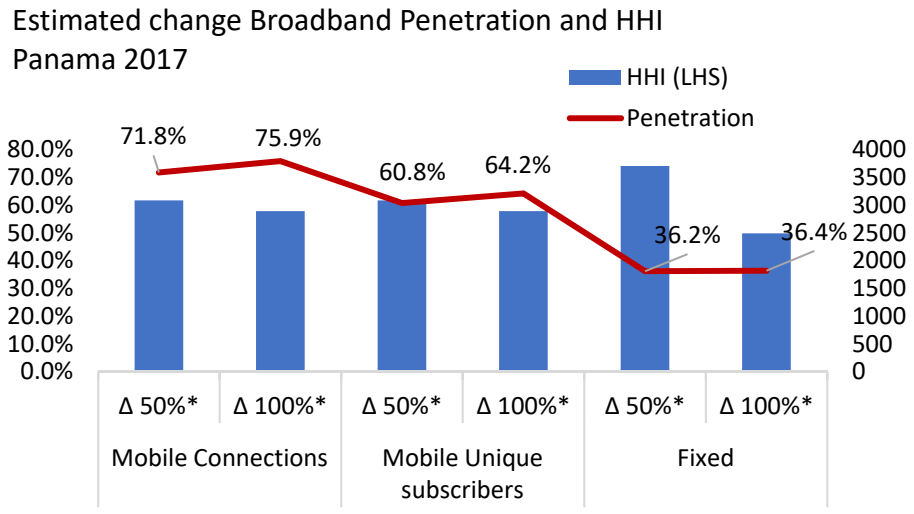
[63] Competition index=0 if 0 competitors, 1 if there is 1 competitor and 2 if there are 2 or more competitors.

decrease by 12%, and the mobile broadband penetration will increase 7 percentage points.

- A 1% decrease in fixed broadband penetration is associated with a 0.02% increase in fixed broadband penetration (per household).
    - In the context of Panama's actual market. If Panama achieves to improve competition to the same level as the best of the comparable countries (Colombia), the HHI index will decrease by 49%, and the fixed broadband penetration will increase 1.0%.

The following two graphs show the actual levels of penetration and HHI for Panama and the estimated changes if HHI improves to the same level as the best comparable or half way that level.





Δ 100%: Panama's HHI decreased to the same level as best comparable.
Δ 50%: Panama's HHI decreased until the distance is reduced to half.

Investment and Infrastructure

Panama

In addition to competition, and even Panama authorities have promoted investment throughout different policies and programs, more has to be done to promote the deployment of infrastructure. Mostly since 5G, IoT and other disruptive models will be fully implemented in the short term. Therefore, some countries, like the ones shown below, have undertaken measures and policies to boost investment and deployment of infrastructure.

Mexico

The Telecommunications Reform achieved progress in the implementation of programs focus on infrastructure development. The flagship project of the Reform is the "Red Compartida" which objective is to expand coverage and decrease the technologic gap. Red Compartida will give operators the potential to exploit a nationwide 4G infrastructure to boost investment. Another positive measure was the elimination of restrictions on Foreign Direct Investment.

Table 13: Investment and infrastructure articles in Mexico

Mexican Constitution	
FDI on telcom	Art. 5 transitory
Red Compartida	Art. 16 transitory
Ley de Federal de Telecomunicaciones y Radiodifusión	
Sole Concession	Art.71

Spain

Spain developed a National Plan of 5G to encourage investments in the deployment of 5G infrastructure. They expected to increase broadband speed to 100 Mbps-1 Gbps. Moreover, they estimated a direct economic impact of 62,500 million euros in 2025 and an indirect impact of 113 million euros.[64] Spain's plan is based on European 5G action plan.[65]

[64] http://www.minetad.gob.es/telecomunicaciones/es-ES/Novedades/Documents/plan_nacional_5g.pdf

[65] https://ec.europa.eu/digital-single-market/en/news/communication-5g-europe-action-plan-and-accompanying-staff-working-document

Table 14: Spain 5G plan

Spain: Action Plan 5G	
1	*"Gestión y planificación del espectro radioeléctrico. Acciones dedicadas a garantizar la disponibilidad en los plazos adecuados de las diferentes bandas de frecuencias necesarias para la prestación de los servicios de comunicaciones sobre redes 5G."*
2	*"Impulso a la tecnología 5G: Pilotos de red y servicios y Actividades I+D+i. Experiencias piloto y casos de uso impulsados por la Administración destinados a facilitar a operadores, suministradores, fabricantes de equipos e industria en general experimentar con la nueva tecnología que permita desarrollar ecosistemas 5G y asegure una prestación futura adecuada de los servicios 5G e identificar nuevos modelos de negocio. También se incluyen acciones de promoción del emprendimiento, la investigación y el desarrollo de servicios innovadores que faciliten la creación de un ecosistema español de provisión de servicios, contenidos aplicaciones y plataformas 5G."*
3	*"Aspecto regulatorios. Identificación y desarrollo de instrumentos legales, adicionales a los relacionados con la gestión del espectro que sean necesarios para proporcionar un marco jurídico adecuado y flexible que proporcione la seguridad jurídica imprescindible para incentivar y facilitar las inversiones necesarias para el despliegue de las infraestructuras y tecnologías 5G."*
4	*"Coordinación del Plan y cooperación Internacional. Desarrollo de infraestructuras de gobernanza y coordinación de las medida incluidas en el plan y acciones de cooperación internacional y apoyo y seguimiento de los trabajos de estandarización de la 5G."*

Analysis

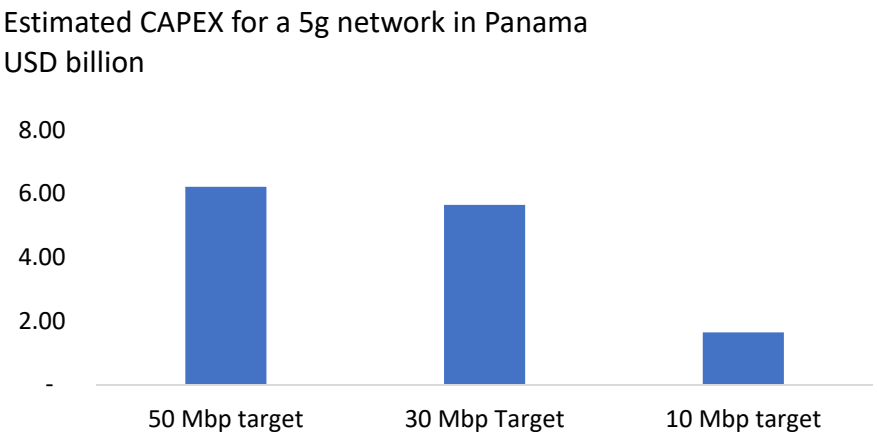
Oughton and Frias (2017) estimated the cost and rollout implications of 5G networks across Britain for the period 2020-2030.[66] They developed a cost model that capture the strategies that operators may need to implement to offer 5G. In the base scenario investing 58.8 billion dollars from 2020-2030, ultrafast broadband (50 Mbps) coverage will reach 90% of the population by 2027.

Table 15: Estimated CAPEX for a 5g network in the UK

	Target speed scenarios		
	50 Mbp	30 Mbp	10 Mbp
Total Costs 2020-2030 (USD bn)	**58.8**	**51.8**	**16.8**
Urban (%)	16%	11%	28%
Rural (%)	84%	89%	72%
Total cost per capita (USD)	0.9	0.79	0.26
Cost per capita Urban (USD)	0.18	0.11	0.09
Cost per capita Rural (USD)	4.2	3.92	1.03

Doing a simple extrapolation of the estimated CAPEX to deploy a 5G network in Britain, Panama estimated cost is 6.2 billion dollars for a 50 Mbps target and 5.64 billion dollars to achieve a 30 Mbps target.

[66] Oughton, E. J., & Frias, Z., Exploring cost, coverage and rollout implications of 5G in Britain, Engineering and Physical Sciences Research Council (2016). http://www.itrc.org.uk/wp-content/uploads/Exploring-costs-of-5G.pdf



Spectrum

Panama

Radio-electric spectrum is a critical input for the deployment of modern wireless technologies, and as a scarce resource, it is essential to allocate it efficiently. An efficient spectrum allocation implies greater services coverage, greater wireless velocity, insertion of new services and technologies and it also brings a significant exploitation rent for the government. Therefore, some questions like how many spectrum is going to be assigned, how much is going to cost, what will be the use of it, among other subjects are fundamental concerns for the policymakers and telecommunication regulators. In the case of Panama, the country is well below other similar countries in terms of allocated spectrum. The lack of spectrum allocation is directly related to the concession regulation explained at the beginning of this section. In addition, the price of spectrum is fixed and has not been updated in several years. As a consequence, in case the authorities of Panama decide to put in the market additional bands of the radio-electric spectrum, its costs could be so high that either the provider that gets the spectrum does not have any room to invest or none of the existing providers would show interest to get an additional concession to exploit the bands.[67]

In this context, following ITU recommendations and the developed countries experiences, Latin America countries have done advances in spectrum allocation and in the regulatory framework, some examples are presented below.

Chile

In Chile 425 MHz has been assigned for telecommunications services through comparative selection mechanism, which relies on a discretionary election of the spectrum regulator among firms' proposals. Also, SUBTEL imposes obligations to each spectrum bidder such as tariffs reduction, increase in coverage (especially in rural zones), and the requirement to offer interconnection. Chile has an amount of

[67] In some cases, such as in the 700 MHz, Panama´s authorities applied a discount so the price of the spectrum could be closer to international benchmarks. Nonetheless, under the current laws, the real valuation of the spectrum in Panama would be far from reality.

allocated spectrum that overcomes most of his Latin-American peers. However, there is an open question whether the spectrum is in the hands of the most efficient agents in the economy De Solminihac (2018).

Colombia

Colombia has an independent spectrum agency (ANE) that facilities coordination among telecom providers and the government. Also, it provides technical support for the bidding process and on the designing of the spectrum regulatory framework. One of the main pillars of Colombia's spectrum regulatory framework is technology neutrality and the auction mechanism. The former promotes technology innovation, and the latter is the most used mechanism to assign spectrum efficiently. Furthermore, in the bidding process, firms are subject to coverage obligations and contributions to reduce the digital bridge. For example, on the 4G auction telecom providers were obligated to deliver thousands of tablets to poor people.

Mexico

Another significant case is Mexico. It has allocated 454 MHz through an auction mechanism, one of the highest spectrum assignments in Latin America. IFT manages spectrum biddings and designs the roadmap for future spectrum allocation, in a yearly publication "National Spectrum Plan," that reveals autonomy and central decision planning by the agency. The National Spectrum Plan aims to allocate 594 MHz in 2019.

Analysis

As mentioned before, spectrum is considered an essential asset for the implementation of new modern mobile technologies and the improvement of the existing ones; it impacts deployment costs, and finally affects affordability and quality. Several articles have measured the impact of additional spectrum on consumer's and firm's welfare and the economic impact of alternative regulatory regimes. Hazlett et al. (2009) measure the social benefits for countries that make more spectrum available and has performed regulatory reforms. Estimating and simulating a structural model for Latin America countries, they find that an increase of 20 MHz causes an average change in consumer surplus in the sample of approximately US$50 per capita.

Carreón et al. (2013) adapt Hazlett model to study the social benefit of spectrum allocation in Mexico, from a panel containing Colombia, Argentina, Brazil, Chile, Mexico, Peru and Venezuela between 2000 and 2009. They find that in Mexico, 1% of additional spectrum will reduce revenue per minute in 0.49% and each peso obtained by the state in the spectrum auction will produce 7.7 pesos of consumer surplus. Apart from structural estimation methods, a study of Analysis Mason (2012) makes use of willingness to pay surveys in the UK to make a forecast of consumer surplus and the corresponding spectrum impact. The find total direct economic welfare from the use of radio spectrum is £52–56 billion, and that critical sectors of the wireless industry generate revenue totaling £37.3 billion and contribute 117 500 jobs.

The methodology presented here to measure spectrum impact is an adaptation of Hazlett model in a cross-country approach. Due to data limitations, some variables of the original Hazlett model are replaced, and data panel fixed-effects estimation also are not possible. However, the methodology includes more countries to acquire grades of freedom and preserve the structural form of Hazlett (2009). The estimated model is:

$$(1) \quad \ln(P_i) = \propto_0 + \propto_1 \ln(Q_i) + \propto_2 \ln(HHI_i) + \propto_3 \ln(Spectrum_i) + \propto_4 \ln(Popdensity_i) + \propto_5 \ln(Popdensity_i)^2 + \propto_6 \ln(Population_i)^2 + \propto_7 Auc_i + \propto_8 Techneutrality_i + \varepsilon_i$$

$$(2) \quad \ln(Q_i) = \propto_9 + \propto_{10} \ln(Fix_i) + \propto_{11} \ln(P_i) + \propto_{12} \ln(GDP_i) + \propto_{13} \ln(GDP_i)^2 + \epsilon_i$$

The model is a system of simultaneous equation that jointly determine equilibrium price and quantities. Equation (1) specifies how the price is determined in the supply side of the economy, which includes quantity, market concentration (HHI), allocated spectrum, and population costs, the latter being a proxy for capital costs. Equation (2) is a classical empirical demand function, there depends on demand for fixed telephony, price, and income per capita. The fitted model can be employed to estimate the equilibrium prices and quantities that results from an increase in one of the exogenous variables.

The sample contains countries from America, Europe, Africa, and Asia for 2016. In terms of the variables, P_i is mobile phone prices collected from *Measuring information society report* 2017, Q_i is mobile phone subscriptions collected from OVUM, HHI_i is the Herfindahl index collected from GSMA, population density, total population and GDP, are collected from World Bank data. Auc_i is a dummy variable that equals 1 if the country has had 4G auctions, $Techneutrality$ is a dummy variable that equals 1 if the country assigns spectrum with technology neutrality principles, Fix_i is fixed lines subscriptions, and finally $Spectrum_i$ is the amount of spectrum assignment which is collected from www.spectrummonitoring.com (see Appendix B for a more detailed data explanation).[68]

Table 28 on appendix B exhibits the three stages least squares (3SLS) estimation results for a sample of 78 countries. The estimated spectrum coefficient (-0.40) is similar to the one obtained on Carreón et al. (- 0.491) and close to the coefficient obtained in Hazlett et al. (-0.149). If we keep constant all the variables except spectrum we obtain:

$$\ln(P_i) = \propto_1 \ln(Q_i) + \propto_3 \ln(Spectrum_i)$$

$$\ln(Q_i) = \propto_2 \ln(P_i)$$

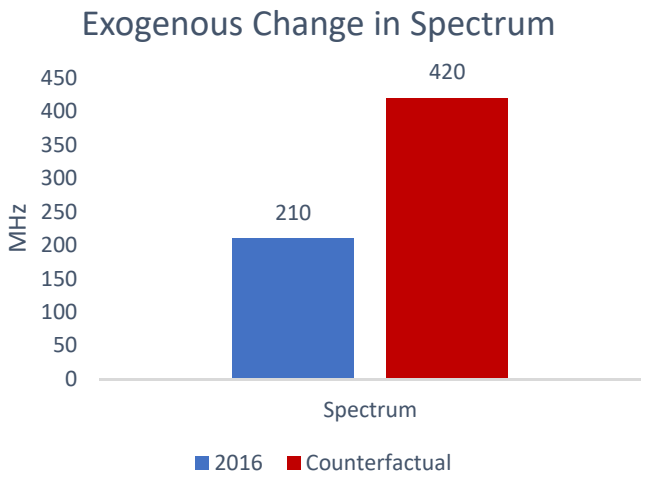
Joining both equations, the associated multiplier to an increase of spectrum is:

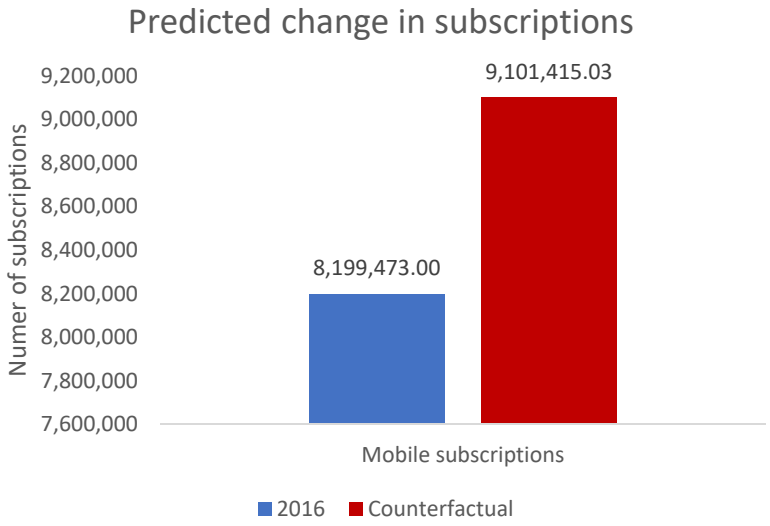
$$\ln(P_i) = \frac{-\propto_3}{1 + \propto_1 \propto_2} \ln(Spectrum_i)$$

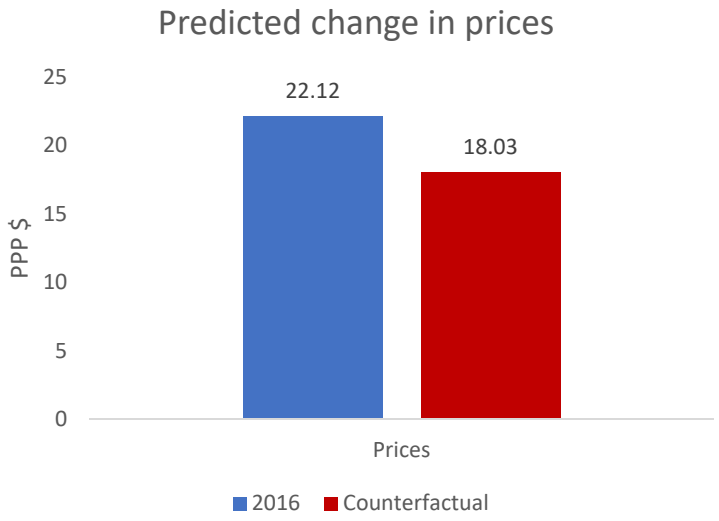
[68] www.spectrummonitoring.com only contains recent spectrum information, to collect 2016 data, we use https://web.archive.org/.

Hence, in the above estimation, a 100% increase in the allocated spectrum will decrease firms' price by -18.48% and will increase subscriptions by almost 11%, Figure 25 exhibits the conclusive results.

Figure 25: Price and subscriptions adjustment from an exogenous increase in spectrum







Tax incentives

Panama

Some other measures that can help to increase investment in the telecommunications sector are tax exemptions. Although Panama has some incentives, those are mostly focused on salaries. Thus, this section provides some examples of tax incentives in the sector and the possible effect they could have on investment.

Mexico

In 2012, OECD recommended to Mexico's authorities the elimination of the special tax on products and services (IEPS) for telecommunication services. Those taxes have a direct impact on the total cost for consumers. Mexico's authorities reduce taxes to some telecommunications services, such as internet data and fixed telephony for rural areas, creating a positive impact on consumer costs. However, OECD continues to recommend the total elimination of such taxes as it is well documented that such taxes can increase 19% the cost of consumers.[69] According to GSMA, a reduction of IEPS from 3% to 1.5% would result in 1.1 million new users and 540 million dollars in investments, whereas a complete elimination would be associated with 2.2 million new users and 440 million dollars in investments.[70]

Table 16: Laws containing tax incentives

Ley del IEPS	
Rate for telecom sector	Art. 2 II c)
Exceptions to rural sectors	Art. 8 IV

El Salvador

According to GSMA, if El Salvador decreases the tax for telecommunications from 5% to 2.5%, 110,000 new connections would be created, and total investment would increase by 70 million over four years (2017-2021), while just representing a 0.34% decrease on government revenues. On the contrary, an increase in the tax rates would be associated with a decrease of 170,000 connections. [71]

Ecuador

In 2008, Ecuador´s authorities decreased taxes for telecommunication services from 15% to 12%. After the reform, the applicable tax for telecommunication services became one of the lowest in Latin America. This resulted in rapid increases in penetration rates and telecommunication services usage.

[69] GSMA/Deloitte (2015), "Digital inclusion and mobile sector taxation 2015", https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/06/Digital-Inclusion-Mobile-Sector-Taxation-2015.pdf.

[70] https://www.gsma.com/mobilefordevelopment/wp-content/uploads/2015/09/GSMA_Mexico-1-pager_Spanish.pdf

[71] https://www.gsma.com/latinamerica/wp-content/uploads/2017/05/GSMA_El-Salvador-English_WEB.pdf

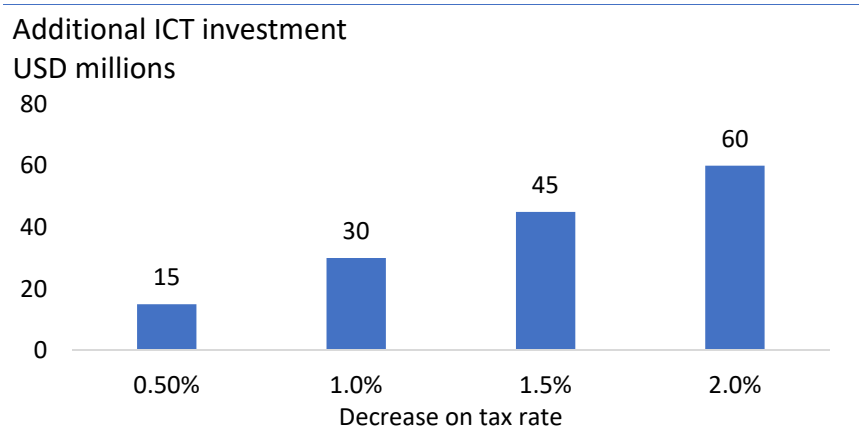
From 2008 to 2012, penetration rates increase from 70% to 110%, while cost per minute of calls decreased 63% and minutes of usage per month increased 133%.

Analysis

According to Deloitte (2012), positive taxation policies contributed to a rapid increase in penetration. However, in 2012 consumer taxes increased and growth rates for penetration decreased. [72] Moreover, telecoms operators were subject to a 30% corporate tax rate, 5 percentage points higher than the normal corporate tax rate from 2010 to 2014. In 2014, telecoms operators were subject to the normal rate of corporate tax (25%). There is evidence that this discouraged investment into Panamanian telecom sector. In addition, Panama applies a special 5% tax to mobile calls, SMS and data usage.

A framework of taxation incentives towards Panama's telecommunication sector could encourage investment and penetration rates in fixed and mobile telecommunications. According to an econometrical analysis published by ITU, a decrease of 1% in the average sales rate applicable to purchased equipment is associated with an increase in fixed and mobile investment per capita of 0.85 cents. They use data from the US.[73]

- In 2016, Panama's investment on ICT was 75 dollars per capita equivalent to 300 million USD; using the results of the paper, a decrease of 1% on the tax rate would be associated with a 1.1% increase on investment per capita equivalent to 330 million dollars (additional 30 million).



Inequality of access

Panama

Information and communication technologies (ICT) have the power to change an entire society; they can improve people's lives on different life components such as education, healthcare, labor productivity, commerce, business, governance among others. Being, such a powerful tool to boosts people's welfare,

[72] GSMA/Deloitte (2012), "Mobile telephony and taxation in Latin America", https://www.gsma.com/publicpolicy/wp-content/uploads/2012/12/GSMA-2012-Latin-America-Tax-ReportWEBv2.pdf

[73] Telecom Advisory Services, LLC, "The impact of taxation on the digital economy", ITU (2016). https://www.itu.int/en/ITU-D/Regulatory-Market/Pages/Events2016/Abidjan/Ses3_2_Katz_Taxation%20v4.pdf

one primary concern for policy-makers is that people can effectively have access to these technologies. If only a part of the population is exploiting the benefits of ICT, the welfare bridge between both parts will be growing over time. In Latin America, the governments have been promulgated laws and policy roadmaps to foster digitalization and at the same time close the digital bridge between different strata of population. Some examples are presented below.

Colombia

The main advances and programs to support equal access to information and communication technologies are contained in the digital agendas. For example, Colombia's digital agenda Vive Digital 2014-2018 aims to connect 1,123 municipalities (100% of the territory) with high-speed Internet connections and attain 27 million of broadband connections. The program Wi-Fi gratis aims to dispose 1000 Wi-Fi zones on 1,123 municipalities, and program Kioskos Vive Digital aims to increase the quality and guarantee the sustainability of 7621 community centers. Besides, spectrum auctions impose coverage obligations to ICT providers and concrete actions that increase digitalization on rural zones.

Mexico

Another example of digital connectedness policy is Mexico's national digital strategy 2013-2018. The agenda fosters digital inclusion and social connectivity through a constant revision of the legal framework and implementation of governments' digital programs. Some of the most important programs are: Mexico Conectado which has connected more than 100 thousand public spaces, such as universities, libraries, school hospitals, among others; 710 tablets delivered in six states and 240 thousand digitals tools to students; Red Compartida, which will provide next-generation mobile communications services to at least 92% percent of the country's population, favoring universal access to information technologies.

Analysis

In order to measure inequality of access of information and communication technologies, it is necessary to understand the primary determinants of ICT access, which can be socioeconomic conditions (ex. marital status, gender, education, labor status, tenure choice, etc.), geographical conditions (ex. Rural zone, urban zone, city location), and economic conditions (income, wages). Some articles have exploited microeconomic data to measure inequality of access; Madden et al. (1997) use experimental design and survey methods to measure ICT access by the Australian citizens. The results suggest that females, the disabled and elderly, and the less well educated are less willing to subscribe, even though they reside in covered areas.

Nishijima et al. (2016) use Brazilian national household surveys from 2005 to 2013 and use logistic regression models to measure inequality of ICT access. They find elderly and rural living people reduces internet usage's probability, besides from 2005 to 2013 rural zone coefficient are negative, while elderly people coefficient are positive. Another example of microeconomic studies is Crespo et al. (2015) they use a household ICT survey that allows a more comprehensive study of ICT access because the survey

also has information on ICT usage and individual ICT skills. They find gender and nationality play a significant role on determining ICT usage, in addition to some other covariates that have already found to be significant in the literature such as age, income, employment situation, and the city of residence.

In pursuance of analyzing Panama's inequality of access, we perform a household survey analysis using data from the national household survey *Encuesta de Niveles de Vida 2008* (ENV). The ENV aims to measure the quality of life, wealth distribution, determinants of poverty, and socioeconomic conditions over a sample of 8,000 households, which is a national representative sample, both at the rural and urban zone. The survey asks if any member of the household has a mobile phone and if the household possesses internet services; both questions allow us to classify households by its telecommunication usage.

Once households are classified according to their telecommunications usage; the analysis consists of evaluating what are the primary determinants that could affect the demand for mobile phones, and internet services at a household or family level. To measure the probability of having a mobile phone and the likelihood of having access to internet services as a function of explanatory factors, a binary response model is used Wooldridge J. M. (2015):

$$P(y = 1|\mathbf{x}) = P(y = 1|x_1, x_2, \dots \dots x_j)$$

The model explains how socioeconomic and geographic variables $\mathbf{x}$ defines the probability that the household has mobile phone or internet use $P(y = 1|\mathbf{x})$, where y is an indicator variable which equals 1 if the household has mobile phone or internet use. The explanatory variables $\mathbf{x}$ are chosen according to related inequality of access literature; consequently, $\mathbf{x}$ contains:

- Household's head gender
- Quantiles of consumption per household
- Household's head age
- Household's head education
- Household size
- Number of children per household
- Number of elderly people in the household
- Household's head Employment status
- Dummy for rural (urban) zone
- Number of elderly people per household
- Province location

Therefore, the model gives us insights about, whether any of these variables significantly explain the probability of mobile phone (internet) use, and which are the main determinants of Panama's digital gap. Thus, to estimate $P(y = 1|\mathbf{x})$, a logistic model is imposed:

$$P(y = 1|\mathbf{x}) = \frac{e^{\mathbf{x\beta}}}{1 + e^{\mathbf{x\beta}}}$$

Table 29 in appendix D presents the results by imposing a maximum likelihood estimation with bootstrapped errors. The main findings are:

- Female households' heads are significantly more prone to demand mobile phone than males, however interacting female dummy with consumption quantiles, we observed that females have in average a lower probability for demand mobile phones;
- On fixed internet demand there is not a significant gender pattern. Either mobile phone demand or fixed internet demand probability, increase with consumption quantiles and education level, which is expected as wealthier people are prone to afford both services, and more educated people have more interest on ICT demand.
- Regarding household characteristics, the negative sign of the coefficient for elderly people can be a signal of low levels of education in the previous generation, which implies a well-known problem in the literature of digital gap for the elderly people, Nishijima et al. (2016).
- In the case of children, the negative sign may reflect that parents believe their children are too young to have ICT access.
- Geographical patterns are significant and reveal a digital gap within the country. First, rural and indigenous zones have negative coefficients that indicate lower mobile phone and fixed internet usage; second, the logistic estimates indicate lower probability of demand in the more impoverished provinces of Panama (Comarcas, Darién, Veraguas, and Coclé, see Table 32), which implies a digital gap in the country. Finally, Table 30 (appendix D) contains the goodness-of-fit measures, which shows that post-estimation results have high predictable power.

Summary

Table 17 summarizes the main results of this section. In general terms, a huge improvement in prices, penetration, investment and inequality of access could potentially boost the sector in Panama in of case authorities undertake the plan of action presented in the next subsection.

Table 17: Main findings

	Panama Actual	Panama Target change
Penetration	Mobile Unique subscribers: 82% Mobile BB unique subscribers: 57% Mobile: 158% Mobile broadband: 68% Fixed: 77% Fixed broadband: 33%	
Competition	HHI: Mobile broadband: 3283 Mobile:3558 Fixed broadband: 4922	HHI: MB: 2891 (-12%) Mobile: 2979 (-16%) FB: 2491 (-49%)
Investment and Infrastructure	300 million USD (2014 investments in telecoms with private participation)	460 million USD per year (6.0 bn dollars from 2017-2030)
Tax	25%	25%
Spectrum[74]	210 MHz allocated 8,199,473 subscriptions 22.11 PPP$ mobile cellular basket	Using the model prediction, 100% increase in allocated spectrum will result in: 420 MHz allocated 9,012,615.03 subscriptions 18.02 PPP$ mobile cellular basket
Inequality of access	2008 household national survey shows, more educated people, the wealthier ones, and people between 26-35 years old have a higher probability to demand ICT. Also, indigenous, rural zones and the poorer provinces have a lower probability of acquiring ICT goods.	It is necessary to replicate our 2008 findings on a more recent survey to observe how inequality of access patterns have evolved over time.

[74] The data presented in the table, is the sample data for the regression model therefore it is 2016 Panama's data.

Recommendations

Following the success cases and the deep impact that those policies can have in Panama, in this subsection we provide a plan of, action in the form of a list:

1. **Competition**
   a. Concessions. To promote the entrance of new competitors, create the figure of a unique concession to provide all kind of services. Also, to promote infrastructure sharing and the secondary market, break the concession in two types, to provide services and as the owner of certain bands of the spectrum.

   b. Unique authority. Establish ASEP as the only authority of competition in the telecommunications sector to eliminate the double window and leave the competition analysis to the specialized public body, ASEP. Under this new framework, ASEP must be able to establish the methodology to identify the incumbent (or incumbents) in fixed and mobile services.

   c. Enforceable laws. In case of anticompetitive practices, ASEP should be empowered to set the fines that are proportional. Proportional refers to the severity of the practice and the size of the company.

   d. A specialized judicial body must be established, due to the complexity of the sector.

   e. Concentrations and M&A should also be part of ASEPs capabilities.

2. **Spectrum**
   a. Valuation and costs. The price of the spectrum should be obtained by a competitive auction process, which considers the current market conditions in Panama and considers other benchmarks.

   b. Fast-track auctioning process. Identified bands for IMT services should be auctioned in the short-term, i.e., one year. Also, Panama should consider the liberalization of bands that are currently used for MDDS services, like the 2.5 GHz.

   c. Dynamic sector. The time of the concession should be ten years as a maximum.

3. **Investment**
   a. Taxation system. A decrease in corporate, sale and other taxes for telecommunication services.

   b. Implementation of Public-Private projects for the expansion of last generation networks.

c. Underground optical fiber. Deployment of more underground optimal fiber can be achieved by the creation of a new law that sets the rules for operators on underground wiring, in specific optimal fiber.

d. Regional policies to take advantage of roads construction. In this case, road and highway projects could reduce the cost of backbone deployment derived by the presence of scale economies.

4. Inequality

a. Coverage conditions for service providers. Consider the establishment of mandatory conditions to deploy infrastructure and networks in some regions in which there is no service, or the access is difficult.

b. Reduce the digital gap that currently exists in Panama. This can be achieved with alphabetization policies, development of e-government programs and the creation of a 5.0 digital agenda, with an emphasis on universal access and consumer´s empowerment.

These actions will require the coordination between different authorities and Panama´s government to reform several laws. Most, if not all, of the bottlenecks in the telecommunications sector, can only be solved by changes in the current legal framework.

One key factor to success in this plan of action is a holistic Reform of the sector, otherwise individual policies would not have the desired impact. Also, continuity of the actual programs and policies is imperative, since the cost of learning in a complex sector has already been internalized by several authorities in Panama, such as AIG and ASEP.

As a matter of fact, in case that Panama can achieve such a Reform, its sector will show a deep transformation, like other success cases. The next chart summarizes the effects that each of the actions could potentially have in Panama not only in the sector but all the economy.

Overall findings and Outlook

This last section provides a summary of the main findings of both volumes. Also, it measures the overall short-term economic impact of implementing the policy recommendations concerning competition, spectrum, investment, and inequality. In the end, we provide long-term recommendations related not to the 4.0 digital revolution but the 5.0 data era.

Review of Panama´s telecommunications sector and development of TICs

This two-volume study provides a policy guideline that draws from international experience and economic analysis to recommend some policies that are expected to foster the development of ICT in Panama.

The first volume identifies ICT policies that are expected to have the greatest impact if implemented in Panama; especially those related to e-applications. The analysis relies on evaluating the outcomes of ICT policies around the world and then compare those policies to Panama's greatest gaps. This study can provide a policy pipeline worth of further analysis, adaptation, and implementation.

This volume finds gaps in policy, infrastructure, and e-applications. On the policy side, the biggest difference from comparable best-practice is the concessions model. The second gap in policy is related to dominance. Panama conducts yearly reviews of dominance but lacks clear measures and methods to deal with dominance. On the infrastructure side, the biggest gap with respect to comparable best-practices is the lack of spectrum allocated to mobile services. A related gap is the high price of the allocated spectrum. On e-applications, there is a considerable gap on e-government. Compared to other countries, Panama offers little information to the public and a minor level of engagement on e-consultations processes.

First volume	
Identification of main gaps in policy, infrastructure, and e-applications.	
Policy side	
Concessions model	
Panama	The government defines 20-year telecommunication concessions, including spectrum and rights to future spectrum allocations. Prevents free entry and reduces market innovation.
Best Practice	Involves allowing free entry and allocations of spectrum band on a competitive basis.
Dominance	
Panama	Resolution 1334 of 1999 determines whether a telecom provider has a dominant position in the market. It dictates that a firm has a dominant position if it has temporal exclusivity, participation that exceeds on 15% that of the competition, or it has participation on the HHI that exceed 20%. The dominance remedies, however, are not well-established.
Best Practice	Clear measures and methods to deal with dominance
Infrastructure side	
Spectrum allocated	
Panama	Panama has the most limited supply of spectrum, and it's the most expensive among comparable countries. Panama has allocated 240 MHz of the spectrum whereas the average for its comparable countries in the region is 437 MHz.

Best Practice	The International Telecommunications Unit recommends allocations between 1,340 MHz and 1,960 MHz to be used for mobile communications (ITU M.2290) by the year 2020.
E-applications side	
E-government	
Panama	Panama offers little information to the public and a minor level of engagement on e-consultation processes as evidenced by two e-government international indices in which Panama performs significantly worse: The E-Participation Index and the Online Service Index.
Best Practice	Continuous report of the ICT industry, E-consultation process, and Efficient online transactional services

The second volume provides a policy guideline that draws from international experience and economic analysis to recommend some policies that are expected to foster the development of ICTs in Panama, as well as to provide insights and guidelines of the most recent developments in regulation for new technologies and platforms, such as cybersecurity and Internet of Things (IoT), among others.

The main result from the second volume is the identification of Panama red-flags in Regulatory authorities (effectiveness in law making and judicial independence low ranking is caused mainly by the parallel faculties between ASEP and ADECO), competition regulation and, spectrum regulation. In addition Panama of areas of opportunity for Access and quality, Investment and infrastructure deployment. We present a detailed action plan to improve each red flag and areas of opportunity. However, a key factor is a holistic Reform of the sector, otherwise individual policies would not have the desired impact.

Second volume	
Identification of red-flags in Regulatory Authorities, competition regulation and, spectrum regulation. Areas of opportunity for Access and quality, Investment and Infrastructure.	
Regulatory authorities	Unclear division of faculties between the principal agencies that regulate the telecommunications sector, mainly in competition, M&A and consumer´s protection and empowerment.
Competition Regulation	Parallel competencies between ASEP and ADECO hinder and delay the development and implementation of rules and regulation to prevent anticompetitive practices.
Spectrum regulation	Panama is behind on assigned spectrum with respect to comparable countries and the OECD average. This situation is mainly due to the lack of programs to identify more spectrum bands for IMT services.
Access and quality	Low immersion of ICTs across regions
Investment	Entry barriers. Specific programs and plans for infrastructure deployment have not been developed in the country. Additional tax incentives are needed.
Recommendations	
One key factor to success in this plan of action is a holistic Reform of the sector	
Competition	Concessions, Unique authority, and Enforceable laws
Spectrum	Valuation and costs, Fast-track auctioning process, and reduction of the concession period
Investment	Taxation system, implementation of Public-Private projects, and Underground optical fiber
Inequality	Coverage conditions for services providers, Alphabetization policies, e-government programs, and 5.0 digital agenda

First volume

This study delivers an economic analysis that quantifies the potential benefit of adopting one or several policy recommendations that are expected to boost the ICT sector in Panama, especially e-applications. This study follows the set of objectives identified as fundamental in the Latin American and the Caribbean toolkit by OECD-IDB (2016) (the "toolkit"). The set of policies under consideration are listed below:

1. Maximize the social and economic utility of spectrum use
2. Lowering, and where appropriate, eliminating administrative entry barriers
3. Increase the availability, penetration, and use of telecommunications services
4. Facilitating efficient access to rights of way and passive infrastructure
5. Provide a level field for competition in allocating spectrum
6. Ensuring effective and efficient interconnection
7. Establishing an investment-friendly environment
8. Facilitating demand-side competition
9. Monitoring and assessing dominance
10. Encouraging private investment extending broadband access
11. Ensuring access to infrastructure controlled by dominant operators
12. Solving critical bottlenecks for infrastructure deployment and use

This study identifies a core sets of metrics to measure progress with respect to the objectives identified in the toolkit. Specifically, we focus on: mobile population coverage, households with Internet access, internet bandwidth per user, secure internet servers, unique mobile subs, mobile penetration, mobile broadband penetration, fixed penetration, fixed broadband penetration, individuals using the Internet, fixed broadband Internet tariffs, and prepaid mobile cellular tariffs. The core set of metrics is available for many countries and is kept up to date by industry leaders and international organization, is organized around three categories: coverage, penetration, and affordability.

The study identifies Chile, Colombia, Costa Rica, Ecuador, Mexico and Spain as a set of comparable countries based on a similarity test with the intention to look at the set of policies that countries have used to achieve their goals.[75]

In principle, the universe of policies that could be used by policymaker is vast and varies across regions and time. The universe of policies comprises three sectors and three branches of government. The sectors under consideration are fixed networks, wireless networks, and the internet. Since policies are executed at all levels of government, this study includes the legislative, the executive and the judicial powers. For the legislative power, the analysis considers the latest major legal reforms in the telecommunication sectors. For the executive power, the "digital agendas," and the "national infrastructure plans" are analyzed. For the judicial power, the outcome and stakes of the latest major legal cases are considered.

Access is only the first step when maximizing the benefits of Information and Communication Technologies. The specific applications being used are of paramount importance. The Network Readiness Index provides a quick visualization of the state of e-application for comparable countries. In

[75] Mexico and Spain are included as reference countries. In the past, Panama has designed policies based on these countries. See, for example, the Panamanian digital agenda 2014-2019.

general, Panama is aligned with its peers. However, there is a significant gap in government online services and e-participation.

This analysis provides a comprehensive review of successful applications launched in the world and the comparable countries with respect to health (e-health), trade and business (e-commerce), education (e-education) and government (e-government). In addition, it describes uses and results of technologies in each of the four sectors based on recent literature and practical examples.

Finally, this volume identifies major gaps in regulation, public policy, and infrastructure in Panama. Closing these gaps will accelerate the development of e-applications and foster access to reliable ICT services at affordable prices for the greatest number Panama citizens.

The main important gaps identified are in public policy, infrastructure, and e-applications.

1. On the policy side, the biggest difference from comparable best-practice is the concessions model. In Panama, the government defines 20-year telecommunication concessions, and interested parties bid on them. These concessions include spectrum and rights to future spectrum allocations. This model prevents free entry and reduces market innovation. The best practice involves allowing free entry and allocations of spectrum band on a competitive basis, an auction preferably. The Panama policy distorts prices and allocations as new allocations or spectrum are not open to competition or price discovery. The second gap in policy is related to dominance. Panama conducts yearly reviews of dominance but lacks clear measures and methods to deal with dominance.
2. On the infrastructure side, the biggest gap with respect to comparable best-practices is the lack of spectrum allocated to mobile services. Panama has the most limited supply of spectrum, and it's, maybe not surprisingly, the most expensive among comparable countries. Panama has allocated 240 MHz of the spectrum whereas the average for its comparable countries in the region is 437 MHz. The most notable gap with respect to the comparable countries is the lack of spectrum in the 2.5 GHz frequency band, which is allocated to restricted television in Panama.

   This spectrum gap as sizable consequences on many aspects of the industry. First, the quantity and quality of mobile services that telecommunication companies can provide are reduced; second, this reduction of output has direct consequences on prices and the affordability of telecommunications; finally, the reduced output and higher prices reduce the economic welfare (consumer and producer surplus) of the Panamanian society.

   In terms of mobile speed, Panama is the second worst in the set of comparable countries. This reduced speed limits the use of certain mobile applications. For example, video streaming and video calling on mobile phones require consistent speeds around 7 Mbps.[76] The average speed in Panama makes this kind of applications unreliable since the speeds will be much slower in moments of high demand.

3. On e-applications, there is a considerable gap on e-government. Compared to other countries, Panama offers little information to the public and a minor level of engagement on e-consultations processes.

[76] https://help.directvnow.com/hc/en-us/articles/211978106-Internet-speed-recommendations-for-optimal-streaming

Panama actively participates with a number of organizations that keep track of country performance on a number of measures, e.g., the World Economic Forum's Global Competitiveness Index. In general, Panama performs relatively close to comparable countries. However, there are two international indices in which Panama performs significantly worse: The E-Participation Index and the Online Service Index.

The e-participation index is a survey focusing on the use of online services to facilitate the provision of information by governments. It contains three stages, e-information sharing, e-consultation, and e-decision-making. In all three cases, Panama has the lowest score of the group. However the lag against the leader and the next best widens as the stage evolves. The gap versus Spain, the best in all stages, evolves as follows: 55%, 50%, and 68%. The gap versus the next best, Ecuador, evolves as follows: 20%, 21% 32%.

According to the United Nations, the Online Service Index attempts to evaluate the quality, scope, and utility of online aspects of e-government based on a single internationally-comparable value using a four-stage model of online service maturity. The index assumes four stages of online services: Emerging information services, Enhanced information services, Transactional services and connected services. Panama's performance, when compared to the comparable countries, is deficient. In all but the first stage of online services, Panama lags significantly with respect to the leader and the next best. In the case of Enhanced Informational Services, Panama is 53% behind the leader and 20% behind the next best. The respective gaps are 70% and 49% for the Transactional Services Stage and 65% and 24% for the Connected Services Stage.

Second volume

This document is the second of a two-volume study that provides a policy guideline that draws from international experience and economic analysis to recommend some policies that are expected to foster the development of ICTs in Panama, as well as to provide insights and guidelines of the most recent developments in regulation for new technologies and platforms, such as cybersecurity and Internet of Things (IoT), among others.

First, we divide the analysis into two parts: (i) the regulatory areas of opportunity identified by studying Panama´s law and programs in telecommunications and digital adoption, and (ii) using two new regulatory indexes, we match the regulatory deficiencies with key indicators in Panama´s telecommunications sector.

In general terms, from both, analytic and legal analysis, we identify Panama three red-flags:

- Regulatory authorities (effectiveness in law making and judicial independence low ranking is caused mainly by the parallel faculties between ASEP and ADECO),
- Competition regulation and,
- Spectrum regulation.

In addition, Panama has two areas of opportunity in:

- Access and quality,
- Investment and infrastructure deployment.

Thus, we summarize the key areas in which Panama can improve in four:

1. Competition: high prices, low investment, and quality
2. Spectrum: high costs, low penetration, and quality
3. Investment: entry barriers
4. Inequality: low immersion of ICTs

These key areas have metrics which directly reflect the possible gaps between Panama and other countries. For example, the lack of competition can be related to high prices to the users. The lack of spectrum allocation and its high cost is related to low penetration, investment, and speed. Also, inequality of access between different regions in Panama is related to the low impact that digital policies have had in the country.

In this context, and given the digital environment, Panama´s authorities should work in holistic policies and regulatory changes, since some of the main bottlenecks are related to access barriers for the new entrants, others are related to the backbone – the highway- in which data traffic of new businesses and digital platforms will circulate, and others are related to the alphabetization and immersion of ICTs to Panama´s population.

Thus, regulatory changes by themselves are not enough, digital strategies without connectivity are not enough and vice versa. Having this in mind we provide a plan of action based on our main results on analyzing international success cases (of countries like Mexico, Spain, Colombia, among others) and the deep impact that those policies can have in Panama, considering that most of them should be implemented at the same time of very close one to another.

Competition

1. Concessions. To promote the entrance of new competitors, create the figure of a unique concession to provide all kind of services. Also, to promote infrastructure sharing and the secondary market, break the concession in two types, to provide services and as the owner of certain bands of the spectrum.
2. Unique authority. Establish ASEP as the only authority of competition in the telecommunications sector to eliminate the double window and leave the competition analysis to the specialized public body, ASEP. Under this new framework, ASEP must be able to establish the methodology to identify the incumbent (or incumbents) in fixed and mobile services.
3. Enforceable laws. In case of anticompetitive practices, ASEP should be empowered to set the fines that are proportional. Proportional refers to the severity of the practice and the size of the company.
4. A specialized judicial body must be established, due to the complexity of the sector.
5. Concentrations and M&A should also be part of ASEPs capabilities.

Spectrum

6. Valuation and costs. The price of the spectrum should be obtained by a competitive auction process, which considers the current market conditions in Panama and considers other benchmarks.
7. Fast-track auctioning process. Identified bands for IMT services should be auctioned in the short-term, i.e., one year. Also, Panama should consider the liberalization of bands that are currently used for MDDS services, like the 2.5 GHz.
8. Dynamic sector. The time of the concession should be ten years as a maximum.

Investment

9. Taxation system. A decrease in corporate, sale and other taxes for telecommunication services.
10. Implementation of Public-Private projects for the expansion of last generation networks.
11. Underground optical fiber. Deployment of more underground optimal fiber can be achieved by the creation of a new law that sets the rules for operators on underground wiring, in specific optimal fiber.
12. Regional policies to take advantage of roads construction. In this case, road and highway projects could reduce the cost of backbone deployment derived by the presence of scale economies.

Inequality

13. Coverage conditions for service providers. Consider the establishment of mandatory conditions to deploy infrastructure and networks in some regions in which there is no service, or the access is difficult.
14. Reduce the digital gap that currently exists in Panama. This can be achieved with alphabetization policies, development of e-government programs and the creation of a 5.0 digital agenda, with an emphasis on universal access and consumer´s empowerment.

These actions will require the coordination between different authorities and Panama´s government to reform several laws. Most, if not all, of the bottlenecks in the telecommunications sector, can only be solved by changes in the current legal framework.

One key factor to success in this plan of action is a holistic Reform of the sector, otherwise individual policies would not have the desired impact. Also, continuity of the actual programs and policies is imperative, since the cost of learning in a complex sector has already been internalized by several authorities in Panama, such as AIG and ASEP.

Short-term Impact of Policies

Input-Output analysis

In order to measure, how telecommunication sector impacts the Panama economy, an input-output analysis is performed, which gives a direct and indirect measure of how the economy reacts from a final demand increase in the telecommunication sector. First, we present a brief review of the approach and then explain the implemented methodology.

Review

Use and supply tables provide a detailed accounting method of a country productive structure; it contains disaggregated information on services and goods supply, and data for each sector's intermediate consumption during a year. The Supply-table provides services and goods produced by each sector; it distinguishes among domestic, imported goods and supply at basic or purchase's prices. The use-table contains intermediate goods and services consumption for each sector; besides, the use-table shows goods final demand (private and public consumption, gross fixed capital formation, exports).

Use and supply tables are used as a statistic tool; nonetheless, they do not provide insights for analytical proposes. Thus, to perform robust economic analysis, first, we need to transform supply-use tables into an Input-Output table (IOT). The IOT shows product flows relations between sectors in the economy and the consumers, furthermore it contains specific industry production, and its intermediate inputs demand. The rows of such a table describe the distribution of a producer's output throughout the economy, and the columns describe the composition of inputs required by an industry to produce output. The additional columns, labeled "Final Demand" record the sales by each sector to final markets Miller (2009).

Input-Output models pioneered by Leontief (1941) study interdependence between industries on a general equilibrium approach. The more fundamental framework consists on draw a perturbation in final demand (consumption government exports), and then calculate the direct and indirect impact through the Leontief inverse matrix. Some examples include van den Bergh et al. (2013), they calculate the impact of Spain's economy from a change on tourism demand due to an increase in oil prices; they find a reduction between 0.08% and 0.38% on output. Hsu (1989) links traditional IOT multipliers to energy sector multipliers, which allows a comprehensive study of energy from demand shocks. Lastly, Hughes (2003) provides a summary of the importance of economic multipliers for study employment impacts, feasibility, migration, capital considerations among others.

In Latin America, Hernandez (2012) describes the use of input-output multiplier analysis for the Colombian case, and applies Chenery-Watanabe to measure inter-industry backward and forward linkages; the results show that chemical oil, plastics, electricity, transport, and telecommunications exhibit extensive connectivity. On a similar work, Padilla (2014) estimates the impact multipliers for the Nicaraguan economy and classifies industries according to Rasmussen coefficients'. He finds that cattle sector, electricity, and industrial foods are the key sectors of the economy.

Concerning telecommunications impact, Cronin et al. (1993) estimate productivity gains due to investment in telecommunication infrastructure. Using IOT and the productivity's Peterson Total Index, the authors estimate how telecommunications´ infrastructure has contributed to each sector TFP, and the overall economy; they find an impact of 21.5% on efficiency due to telecommunications for the aggregate economy. Correa (2003) measures the economic impact of telecommunication diffusion on UK productivity growth; she finds that non-related telco industries have increased telecommunication usage by 57% between 1963 and 1996. Furthermore, she obtains that telecommunications technology contributes to a price decline of 16.4% at the aggregate level (84.9% in the telecommunication sector) between 1991 and 1996.

Methodology

Use and supply tables are commonly used for accounting practices; hence, to perform analytical methods, it is required to obtain an input-out table from the use-supply tables. Some official national statistics already contains both the use-supply tables and the input-output table; however, in Panama's case, the IOT must be calculated. Thus, supply-use tables are obtained from Panama's official national statistics webpage, and to perform the transformation to the IOT, the 2015 supply-use table at constant prices is used.

The original table contains 60 goods and services and 71 sectors, but as a symmetric matrix is required to obtain the input-output table. Therefore, related products and sectors are aggregated to obtain a 55x55 symmetric table. Using this symmetric table, we follow the Eurostat manual to transform the supply-use matrix into IOT, Eurostat (Ch. 11 2008). The model implemented to calculate the IOT is the industry-by-industry-input-output under the fixed product sales structure assumption, which implies that each product has its own specific sales structure, irrespective of the industry where it is produced. Following the Eurostat manual:

Table 18: Supply table

	Industries	Output	Imports	Supply
Products	Vt	Q-M	M	Q
Output	Gt			

Source Eurostat

Table 19: Use table

	Industries	Final demand	Use
Domestic products	Ud	Yd	Q-M
Imported products	Um	Ym	M
Value-added	W		W
Output	Gt	Y	

Source Eurostat

Based on use-supply tables (Table 18 and Table 19) the input-output table is obtained through the following transformation:

$$T = V(diag(Q - M))^{-1}$$

$$B = TU$$

$$F = TY$$

Where B and F are the intermediates and final demand industry-by-industry-input-output tables, respectively, and T is the transformation matrix. Then, the input-output coefficients matrix is given by:

$$A = B(diag(G))^{-1}$$

Following Miller et al. (2009) the simple output multipliers are given by:

$$\Delta x = (I - A)^{-1} f$$

$$f = \begin{bmatrix} 0 \\ 0 \\ \dots \\ \dots \\ 1 \\ 0 \\ \dots \\ 0 \end{bmatrix}$$

Where f indicates an additional dollar's worth of final demand for the output of telecommunication's sector, and Δx corresponds to the additional output to satisfy the new dollar of final demand. Hence, the sum of Δx captures the aggregate effect of an additional dollar of a specific sector, such as the telecommunication's sector. Thus, Δx evaluated on the telecommunication row gives the output multiplier effect in the sector. The total and specific multiplier for telecommunication sector in Panama are:

$$\sum_{j=1}^{55} \Delta x_j = 1.6232$$

$$\Delta x_{telecommunications} = 1.2273$$

Hence, the sum of the j sectors gives a total or aggregate output multiplier of 1.6232 dollars from an increase in 1 dollar of final demand in the telecommunication sector. Furthermore a 1 dollar increase in telecommunication final demand results on 1.2273 dollars increase in the sector.

Other economic impacts

Telecommunication technologies make people life more comfortable, and they allow them to send and receive messages instantly over long distances and access to many media content or internet applications that can improve their welfare. Also, telecommunication technologies are related to a decrease in the cost of doing business, diffusion of new economic activities, and improvements in firm's productivity, Fornefeld et al. (2008).

As long as, telecommunication technologies represent an improvement in welfare and economic efficiency, there must be an impact on economic growth after their implementation. Waverman et al.

(2001) using a panel of 21 OECD´s countries over a 20-year period find that about one-third of economic growth can be attributed to telecommunications, while Czernich et al. (2009) find that a ten-percentage-point increase in broadband penetration raises annual per-capita growth by 0.9-1.5 percentage points. Using a sample of 121 countries from 1980 to 2006 Qiang et al. (2009) estimates an econometric model based on Barro's endogenous growth model, they find that a 10% increase on broadband penetration on developing (developed) countries, would increase GDP growth by 1.38 % (1.21) %. Besides, a 10% increase in mobile phone penetration on developing (developed) countries would boost GDP growth by 0.81% (0.6%). Table 20 exhibits the different GDP growth impacts attained in the literature, which are used in the following section to predict fixed broadband and mobile phone impact under alternative scenarios.

Table 20: GDP growth impact in the literature

	Impact in GDP per capita growth	
Article	**1 % increase in mobile phone penetration**	**1 % increase in fixed broadband penetration**
Qiang et al. (2009)	0.081%	0.138%
Fuss et al. (2005)	0.059%	
Czernich et al. (2009)		0.09%
Katz et al. (2012)		0.045%

Predicted short-term policies impacts

The second section of this volume establishes a set of policy recommendations that will modify inefficient practices and will boosts sector's growth. However, each recommendation is tied to a specific metric that isolates each recommendation from each other. Thereby, to make recommendation comparable at the aggregate level and to use only one metric, this section measures the final impact of the policies on GDP short-term growth.

Competition analysis

Competition analysis predicts that if Panama's fixed broadband HHI index decrease by 49%, fixed broadband penetration will increase by 1%. Using literature elasticities (Table 20), we calculate the GDP growth impact for a 1% increase under three possible scenarios: A higher impact scenario that takes the highest elasticity, a minimum impact scenario that takes the lowest elasticity and an average scenario, which takes the average elasticity for a fixed broadband impact. The three scenarios result in:

- High impact: 1% increase in fixed broadband penetration impacts GDP growth by 0.138%
- Average impact: 1% increase in fixed broadband penetration impacts GDP growth by 0.091%
- Low impact: 1% increase in fixed broadband penetration impacts GDP growth by 0.045%

Spectrum

Based on a cross-country adaption of Hazlett (2009), it is found that an exogenous 100% increase on the allocated spectrum decrease firms price by -18.48% and increase mobile phone subscriptions by almost 11%. Similar to the previous analysis, we compute three GDP growth scenarios for an increase in mobile telephony penetration[77]:

- High impact: 11% increase in mobile phone penetration impacts GDP growth by 0.891%
- Average impact: 11% increase in mobile phone penetration impacts GDP growth by 0.77%
- Low impact: 11% increase in mobile phone penetration impacts GDP growth by 0.649%

Investment and infrastructure

Investment and infrastructure analysis calculates the amount of investment that Panama would require to achieve high-speed internet. A target of 30 Mbps speed internet requires an investment of 564 million dollars, and a target of 50 Mbps requires an investment amount of 620 million dollars. To measure how the additional investment in telecommunications would impact GDP growth, we use the input-output final demand multiplier of the previous section. The overall impact on the economy for both speed targets are:

- 620 million dollars of additional investment for the 50 Mbps target will produce 1.044 billion dollars for the overall economy. Also, an additional investment of 620 million dollars will produce 760.9 million dollars in the telecommunication sector. Therefore, Panama's GDP on 2016 was 44.304 billion dollars, then the overall impact expressed as GDP percentage will be 2.36% and 1.72% for the telecommunication sector.

- 564 million dollars of additional investment for the 30 Mbps target will produce 913 million dollars for the overall economy. Also, an investment of 564 million dollars will produce 692 million dollars in the telecommunication sector. The overall impact expressed as GDP percentage will be 2.06%, and 1.56% for the telecommunication sector.

Tax incentives

The tax incentives section concludes that a decrease of 1% on the tax rate would be associated with a 1.1% increase in investment per capita, equivalent to 330 million dollars. To measure how this tax reduction impacts Panama's product, we use again the telecommunications´ specific and overall multipliers calculated in the input-output analysis section. The tax incentive reduction impact gives:

- A 330 million dollars investment in the telecommunication sector will impact overall Panama's product by 534.6 million dollars. Furthermore, the product's impact of a 330 million investment in the telecommunication sector will generate 405 million dollars. The overall impact expressed as GDP percentage will be 1.21% and 0.91% for the telecommunication sector.

[77] The spectrum estimated model take mobile subscriptions in levels, while Table 20 elasticities come from articles that take subscription penetration rates. It is assumed that penetration elasticities can be extrapolated to number of subscriptions.

Inequality of Access

The Inequality of Access section measures how socioeconomic and geographic patterns affects the probability of internet and mobile phone access at the household level. We found that more educated people, people in the urban zones, employed people and wealthier households have a higher probability of accessing ICTs. On the contrary, households that contain older adults, female household heads at the second, third, and fourth quantile of the distribution, and households in the rural have less probability of accessing ICTs. Also, the logit regression shows a lower probability of ICT access at the more impoverished Panama provinces.

The results imply that Panama exhibits inequality patterns on ICT access; thus, the goal is to measure the impact of a reduction in inequality. According to Selhofer et al. (2002), ICT diffusion allows training in job skills that are necessary from a growing number of jobs; it contributes to the equal participation of citizens in the information society; it would trigger the motivation of entrepreneurs towards e-business, and it provides an efficient public service delivery. All of these components, at the end of the day, will boost economic activity and development.

Richmond et al. (2018) provide evidence that suggests a relation between ICT usage and wealth inequality. For middle-income countries (where Panama belongs) mobile phone telephony penetration reduces inequality, while under certain conditions fixed broadband could induce higher income inequality. However, other evidence by Houngbonon et al. (2017) suggests that fixed broadband correlates with lower inequality. Hence, assuming lower inequality of ICT access correlates with lower aggregate wealth inequality, and using Ostry et al. (2014) estimates, we find that:

- For the Panamanian economy (Table 21) a reduction in the Gini coefficient index of one point increases real GDP growth in 0.11 percentage points, while in a 5-point Gini index reduction increases real GDP growth in 0.53 percentage points.

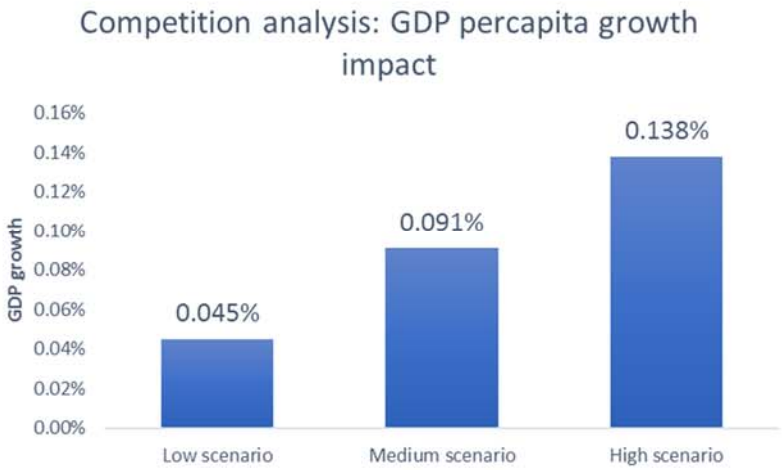
Table 21: Gini impact on real GDP growth per capita

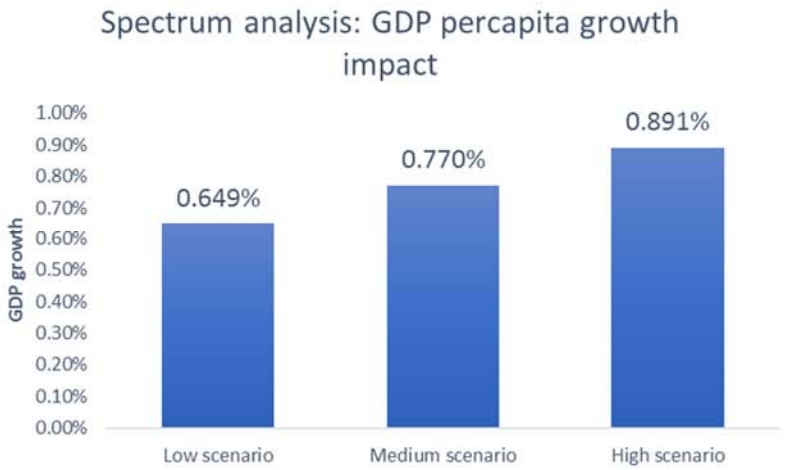
	Actual	Low reduction	Medium reduction	High reduction
Gini coefficient	50.4	49.4	47.4	45.4
Percentage points real GDP growth		0.11	0.32	0.53

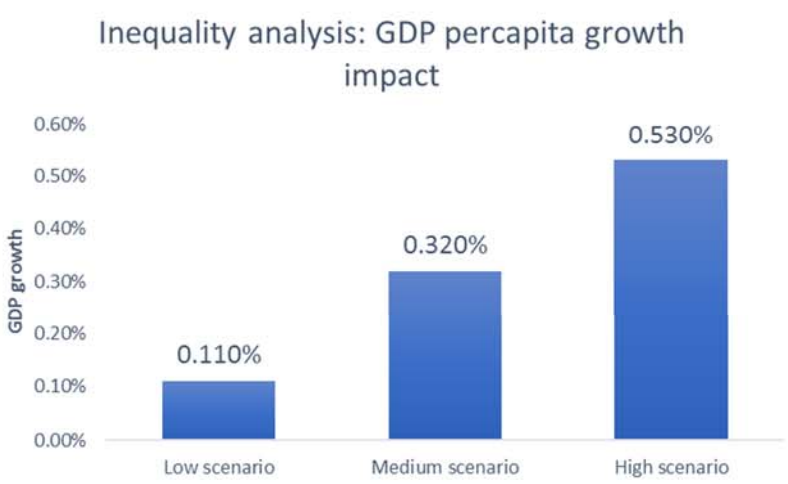
Overall impact

Finally, Figure 26 displays the GDP impact of each policy, while Table 22 exhibits the overall impact on GDP by summing across recommendations and summing between distinct scenarios. Table 22 summarizes the individual impacts on real GDP growth per capita, as well as the total impact of implementing the competition, spectrum and inequality recommendations. In the case of investment, infrastructure, and tax incentives policy effects, we transform their impact in per capita terms by discounting by the average population rate. The total real GDP growth impact is between 2.36% and 3.42%, and Figure 27 shows IMF forecast for GDP per capita growth and both impact scenarios.

Figure 26: GDP growth impact







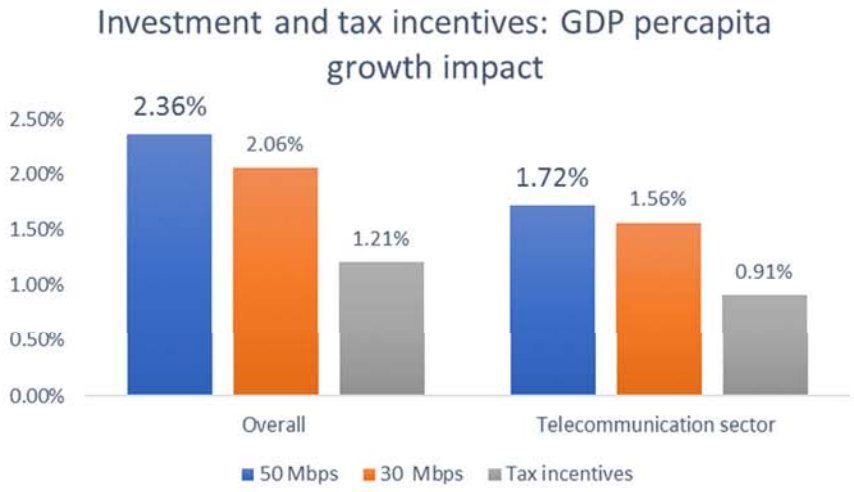


Figure 27: GDP growth rate overall impact

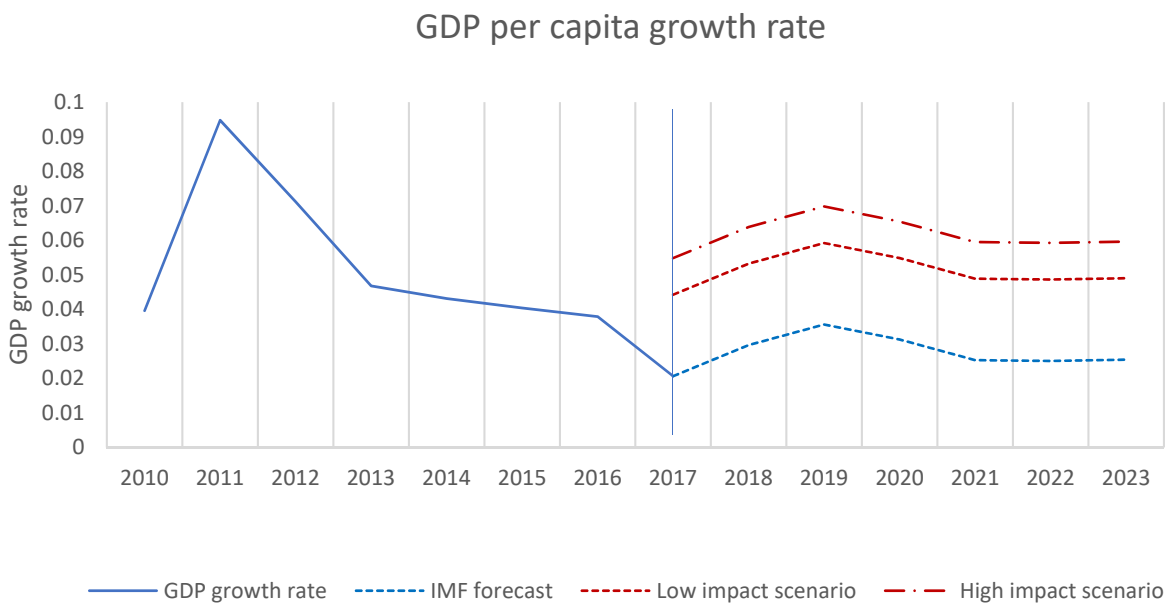


Table 22: Real GDP per capita total impact

	Low scenario	Medium scenario	High scenario
Competition Analysis Spectrum analysis Inequality reduction	0.05% 0.65% 0.11%	0.09% 0.77% 0.32%	0.14% 0.89% 0.53%
Competition, Spectrum, and Inequality real GDP per capita growth impact	0.80%	1.18%	1.56%
Investment GDP growth impact Tax incentives GDP growth impact Population rate	2.06% 1.21% 1.71%	2.21% 1.21% 1.71%	2.36% 1.21% 1.71%
Investment and tax incentives real GDP per capita growth impact	1.56%	1.71%	1.86%
Total real GDP per capita growth impact	**2.36%**	**2.89%**	**3.42%**

Long-term Outlook

Regarding a long-term scenario, several factors, including short-term policies implemented by authorities, must be considered. Among the most critical factors are the political conditions, economic growth, and geopolitical trends.

In addition to those factors, to fully understand the long-term impact of telecommunication services and TICs, we need to comprehend the current context of this sector. In this sense, a few years ago, a fourth industrial revolution, so-called digital revolution or 4.0 revolution, began. This revolution is different from others in several aspects. First, the immersion of connectivity, the development of new business models, the vertical integration of telecommunication operators, and the innovation of new tools grew exponentially.

This fast adoption of digital tools was possible given the highly integrated global environment that most of the countries share among them, for example, international agreements. Another critical factor for the rapid development and adoption of digital services was that the key inputs on which these services operate were already deployed. In particular, most of the infrastructure and the backbone needed for data traffic were already installed in advanced countries; thus, we observed an explosion of innovation and R&D, which started growing at double digits.

Second, the length of this fourth revolution is short in comparison to other industrial developments, mainly due to the accelerated adoption of digital technologies and immersion of connectivity. Consequently, we are about to observe the end of the 4.0 era.

And third, unlike other industrial revolutions, we do not expect the next transcendental change, or revolution will begin in several decades ahead. On the other hand, the fifth industrial revolution has already started.

The 5.0 era is not about connectivity or TICs but is related to the use of data and artificial intelligence. Under this new paradigm, the challenges that regulators and authorities will face are entirely different from those of the 4.0 revolution, mainly because the new problems are less related to physical inputs and more on intangible assets.

Besides, it is important to emphasize that the 4.0 change took place thank you for the existence of enough infrastructure needed to foster connectivity, and the 5.0 is taking place thank you for connectivity. This means that as the network infrastructure – physical inputs, like optical fiber and copper, as well as spectrum - was the key input for connectivity, now connectivity has become the essential input for the data ecosystem of the future.

Under this context, each country should make a broad assessment about the development of connectivity and TICs. If the evaluation results that the nation is close to full connectivity, then it should make a diagnostic about the possible barriers, bottlenecks, and areas of improvement in driven data markets, digitalized economies and sectors intensive in automatizes value chained processes, like the use of artificial intelligence.

In this sense, both volumes of this document focused on the current situation of Panama´s connectivity, the development of telecommunications and TICs. The recommendations aim to boost the sector, so connectivity does not become an obstacle for the future development of data-driven businesses in Panama.

As we discussed in the last subsection, the impact of such short-term policies has the potential to enhance and accelerate the aggregate economic growth in Panama. Nonetheless, in this last section, additional policy recommendations in the face of the 5.0 era are provided. Thus, the long-term outlook policies that Panama´s authorities should consider are:

1. **Competition**

a. Net Neutrality. Panama´s regulator, ASEP, should be entitled to decide whether Internet regulation is necessary or not. Before the ASEP establishes rules about net neutrality and zero rating, it should consult international benchmarks and carry out a study that measures the pros and cons of imposing controls. This is still a topic of debate in which must of the nations around the world, and the points of view change continuously give the dynamics of digital economies.

b. Flexible regulation for new business models and vertically integrated companies.

2. **Spectrum**

a. Design a spectrum market. This input will also be crucial in the 5.0 data revolution. Therefore, Panama´s authorities, mainly the ASEP and AIG, should set incentives and rules that can support a market for spectrum, such as the oil and electricity market of derivatives.

b. Identify high bands for IMT services that can be auctioned under a competitive mechanism.

3. **Investment**

a. Collaborate with the development banking public authority to provide schemes for the development of start-ups and small and medium enterprises in telecommunications, data services, digitize markets and artificial intelligence.

b. Tax incentives to form a regional center for high-tech, innovation and venture capital firms. Panama can take advantage of its geographical position to host a cluster of capital-intensive companies, not only from Latin America but also from around the world.

4. **Cyber-security and Data Protection**

a. Establish guidelines for protection data protection and computer systems. The creation of an autonomous authority is recommended, such institution should have the power to set fines and start judicial processes for those who do not comply with the imposed regulation.

The exact effects of the revolution 5.0 are still uncertain; however, there is a vast literature and articles from operators that estimate significant positive impacts regarding global GDP and employment. For example, according to Ericsson (2017), IoT would add 1.9 trillion dollars to the global economy by 2020 and 11 trillion dollars in 2025, with an investment of 1.3 trillion in 2019. In other words, the multiplier effect will be 1.5 in 2020 and 8.5 by 2025. PWC researchers show that AI would contribute 15.7 trillion dollars to the global economy in 2030 (an additional 30%). 42% of this would come from improvements

in productivity while the remaining 58% would come from consumption side effects. Moreover, 5G deployment would add 12.3 trillion to the global economy and create 22 million jobs by 2035. In Europe, 5G deployment is expected to have a multiplier effect of 2.5 times the investment (56 billion of investment in 2020 with an economic impact of 141 billion in 2025) and create 2.3 million jobs. These effects would create 2.3 million jobs. According to Accenture, 5G deployment in the USA could add 500 billion to GDP and create more than 3 million jobs with an investment of 275 billion over seven years.

Also, the 5.0 data era has the potential to impact the productivity of Panama´s economy. Most of the literature suggests that the impact of ICTs on productivity is positive and significant. Correa (2006) finds that telecommunications have contributed to overall productivity growth directly, and via their influence in other industries. The article shows that without advances in telecommunications, the manufacturing sector, over the sample period 1963–1996, would have been around 16% lower. Also, without advances in telecommunications, productivity losses in the financial intermediation sector could have been 474%, for the period 1991–1996 in the UK. Besides, Basu et al. (2003) relate ICT and aggregate productivity, finding a strong correlation between ICT use and industry TFP growth and suggest that the role of information and communications technology can explain the divergent US and UK TFP performance after 1995. Table 23 shows Cardona et al. (2013) ICT elasticities review at the country and industry level.

Table 23: ICT elasticities review

				Data		
Authors	**Published**	**Elasticity**	**Unit**	**Start**	**End**	**Region**
McGuckin and Stiroh (2002)	2002	0.17	Industry	1980	1996	Americas
Stiroh (2002a)	2002	0.071	Industry	1973	1999	Americas
Acharya and Basu (2010)	2010	0.031	Industry	1973	2004	Worldwide
O'Mahony and Vecchi (2005)	2005	0.066	Industry	1976	2000	Worldwide
Venturini (2009)	2009	0.138	Country	1980	2004	Europe
Dewan and Kraemer (2000)	2000	0.013	Country	1985	1993	Worldwide
Koutroumpis (2009)	2009	0.012	Country	2002	2007	Worldwide
Madden and Savage (2000)	2000	0.162	Country	1975	1990	Worldwide
Röller and Waverman (2001)	2001	0.045	Country	1970	1990	Worldwide
Sridhar and Sridhar (2007)	2007	0.15	Country	1990	2001	Worldwide

Source: Cardona et al. (2013)

Panama is certainly above the countries of the region, but it should rapidly implement the short-term recommendations, so the economy does not stay behind the development of the 5.0 economy, which will profoundly change the social and economic environment of all societies.

Appendix A: Principal component analysis

To obtain a weight for each component of the regulatory index of Table 9, a principal component analysis (PCA) is made. PCA allows to get a relevance measure for a set of factors in a dataset and is often used as a tool for dimensionality reduction on data mining studies. To implement the PCA, first, it is obtained a correlation matrix from Table 9, then a spectral decomposition is performed to the correlation matrix. Finally, the eigenvector that collects more information (the one with the highest Eigenvalue) is taken, and it is standardized to obtain a weighing (PC1 % column on Table 10) for the regulatory index.

Table 24 shows the proportion of variance explained by each component. Component 1 describes 44% of the variance, and according to Table 25, it loads almost equal size for each variable on the regulatory index giving positive values to variables that increase country's regulatory framework and negative values to variables that worsen the regulatory framework. According to the variance explained by each variable, Table 25 shows how infrastructure, regulatory authorities and access and quality mainly explain the regulatory environment in the sample countries.

Table 24: Variance explained by each component

	Eigenvalue	Proportion
Component 1	9.21	0.44
Component 2	4.42	0.21
Component 3	2.92	0.14
Component 4	2.22	0.11
Component 5	1.35	0.06
Component 6	0.88	0.04

Table 25: Principal component analysis

Group	Indicator	PC1	PC1 %
Regulatory Authorities	Effectiveness of law-making bodies, 1-7 (best)	0.29	9.63%
	Judicial independence, 1-7 (best)	0.18	5.98%
General Regulation Framework	Laws relating to ICTs, 1-7 (best)	0.29	9.63%
	Efficiency of legal system in settling disputes, 1-7 (best)	0.21	6.98%
	Efficiency of legal system in challenging regs, 1-7 (best)	0.21	6.98%
	No. procedures to enforce a contract	0.05	1.66%
	No. days to enforce a contract	-0.12	-3.99%
	No. days to start a business	-0.19	-6.31%
	No. procedures to start a business	-0.18	-5.98%
Spectrum Regulation	Spectrum allocated (MHz)	0.26	8.64%
Investment	Venture capital availability, 1-7 (best)	0.14	4.65%
	Investment in telecoms (USD millions)	0.16	5.32%
New Regulation	Availability of latest technologies, 1-7 (best)	0.29	9.63%
	Gov't procurement of advanced tech, 1-7 (best)	-0.04	-1.33%
Access and quality	Mobile network coverage, % pop.	-0.04	-1.33%
	Int'l Internet bandwidth, kb/s per user	0.29	9.63%
	Households w/ Internet access, %	0.29	9.63%
Infrastructure	Electricity production, kWh/capita	0.31	10.30%
	Secure Internet servers/million pop.	0.29	9.63%
Competition	Intensity of local competition, 1-7 (best)	0.28	9.30%
	Internet & telephony competition, 0–2 (best)	0.04	1.33%

Appendix B: Competition analysis methodology

Following the framework set up by Wei Li, we estimated the impact of competition in fixed broadband and mobile broadband penetration. We use data from 2008 to 2017 for 29 countries. The sources of data were GSMA, OVUM, ITU and World Bank.

To measure competition, we use the Herfindahl–Hirschman Index (HHI), a widely accepted measure of market concentration. HHI is computed by summing the square of the market shares of each operator. An index of 10,000 represents monopoly while 0 means perfect competition.

To estimate the effect the impact of a movement on the HHI in fixed and mobile broadband penetration we used a Fixed Effects regression. In specific, we run three the regression for three times of penetration measures: 1) mobile broadband penetration measured as connections per population, 2) mobile broadband penetration measured as unique subscriptions per population, and 3) fixed broadband penetration measured as connections per household. The following table summarizes the results:

Table 26: Fixed effect regression

	(1)	(2)	(3)
VARIABLES	ln_mbpenh	ln_mbpenu	ln_penfb
ln_mbhhi	-1.011***	-0.247***	
	(0.158)	(0.0553)	
ln_pops	9.560***	2.704***	-0.00028
	(1.749)	(0.614)	(0.005139
ln_gdppc	1.982***	0.229	0.0254***
	(0.514)	(0.18)	(0.0069)
popsu	10.82**	6.316***	-0.0842**
	(4.891)	(1.717)	(0.0355)
Year	0.0787***	0.0764***	0.0386***
	(0.0208)	(0.00731)	(0.00719)
ln_fbhhi			0.0249
			80.0453)
Constant	-193.7***	-166.4***	-78.70***
	(36.87)	(12.95)	(14.46)
Observations	203	203	81
R-squared	0.848	0.909	0.687
Number of id	29	29	27

Standard errors in parentheses
**** p<0.01, ** p<0.05, * p<0.1*

Appendix C: Spectrum analysis methodology

Table 27: Model's dataset and variables

Indicator	Description	Variable	Source
Mobile phone subscriptions	Total mobile phone subscriptions in 2016	Logsubscrib	OVUM
Fixed subscriptions	Total fixed voice subscriptions	logfixsubscrib	
Herfindahl index	Herfindahl index for the mobile phone market	logHHI	GSMA
Assigned spectrum	Total spectrum assigned at 2016	logspectrum	Spectrum monitoring (webarchive)
4G auction	Dummy indicating if last 4G auction in the country was assigned through auction mechanism	auction_4g	ICT eye
Technology neutrality	Dummy indicating if the government take into account technology neutrality principles in spectrum allocations	Spectechneutrality	
Mobile phone basket price	Mobile phone basket price at PPP$	logprices	Measuring the information society 2017
Gross domestic product	Gross domestic product at PPP$	loggdppc	World Bank
Population density	People per sq. Km at 2016	logpopden	
Population	Total population at 2016	logpop	

Table 27 shows the data and variables for the econometric model; the sample contains 78 countries that encompass Asia, Africa, Europe, and America; the mobile phone basket price at PPP$ is not available on the Measuring society report 2017. However, it contains the basket price as a percentage of GNI. Therefore, to obtain the basket price at PPP$, the original variable is multiplied by GNI 2016 and divided by the PPP conversion factor. Regarding data collection, all the variables are collected by their respective websites, nonetheless assigned spectrum at 2016 is collected using web.archive.org given that www.spectrummonitoring.com does not have historical data.

Following Hazlett (2009), the model is estimated by three stages least squares estimator, for a further explanation of the method Zellner (1962) provides its properties. The model is estimated in Stata using reg3 command. Also, all the variables are in logs to specify a log-log model that gives an elasticity interpretation of the coefficients. Table 30 exhibits the estimation results. Coefficients differ from Hazlett (2009) because we use different data sources, and a cross-country methodology, however the signs of the coefficients are the same for prices, quantities, HHI, spectrum, and fixed telephony demand.

Table 28: Estimation Results

VARIABLES	(1) logprices	(2) logsubscribtion
Logsubscrib	2.095**	
	(0.981)	
logHHI	0.496	
	(0.504)	
Logspectrum	-0.406*	
	(0.215)	
Logpopden	0.443*	
	(0.236)	
Logpopdensquare	-0.0393	
	(0.0254)	
Logpop	-2.020**	
	(0.942)	
auction_4g	-0.0193	
	(0.185)	
Spectechneutrality	-0.502**	
	(0.198)	
Logfixsubscrib		0.895***
		(0.0613)
Logprices		-0.571*
		(0.329)
Loggdppc		-4.320**
		(2.023)
Loggdppcsquare		0.181*
		(0.104)
Constant	5.737	34.27***
	(4.775)	(9.599)
Observations	78	78
R-squared	-0.240	0.744

Appendix D: Inequality of access analysis methodology

Table 29 presents the logistic regression results for mobile phone demand and fixed internet demand, both regressions has bootstrapped errors.

In mobile phone demand estimation, higher income (proxied by consumption) correlates with higher probability of acquiring mobile phone. Besides, gender patterns, education, age and geographic location significantly explain mobile phone demand probability. In contrast, fixed internet demand doesn't exhibit significant gender and age patterns, but it shows that demand probability increases with the education level. It is worth to mention, how provinces that have negative coefficients (or lower coefficients in absolute value) are the poorer provinces in Panama Table 32, which can be thought as a digital gap within the country.

Table 30 and Table 31 measure whether the model efficiently predicts the household demand of mobile phones or fixed internet, respectively. The percentage of correctly specified values in this case is 80.25% for mobile phone demand and 91.25% for fixed internet services. Sensitivity measures the fraction of observations $y = 1$ that are correctly predicted, while specificity measures the fraction of observations $y = 0$ that are correctly classified, Cameron (2010). Mobile phone demand has high sensitivity (90.96%) and an acceptable specificity (56.23%), while fixed internet demand has low sensitivity (34.52%) and high specificity (97.53%).

Table 29: Logit estimation results

Variables	Mobile phone demand	Fixed internet demand	Variables	Mobile phone demand	Fixed internet demand
Gender and Wealth					
Female	0.586***	-0.130	Indigenous zone	-1.274***	
	(0.158)	(0.135)		(0.290)	
ConsumptionQ2	1.270***	2.656***	Coclé	0.0743	0.336
	(0.110)	(0.393)		(0.167)	(0.352)
ConsumptionQ3	1.606***	4.712***	Colón	0.109	0.218
	(0.122)	(0.422)		(0.175)	(0.255)
ConsumptionQ4	2.101***	6.292***	Chiriquí	1.005***	0.531*
	(0.144)	(0.477)		(0.169)	(0.303)
Female#ConsumptionQ2	-0.488**	0.484	Darién	-0.552***	-0.747*
	(0.207)	(0.461)		(0.164)	(0.408)
Female#ConsumptionQ3	-0.551***	-0.136	Herrera	0.160	-0.174
	(0.213)	(0.265)		(0.166)	(0.344)
Female#ConsumptionQ4	-0.535**		Los Santos	0.717***	0.147
	(0.225)			(0.172)	(0.533)
Age			Panamá	0.254**	0.650***
				(0.127)	(0.203)
(26-35)	0.145	0.0176	Veraguas	0.00427	-0.486
	(0.168)	(0.333)		(0.166)	(0.428)
(36-50)	-0.438***	0.603*	Comarca Kuna Yala	-2.620***	
	(0.157)	(0.313)		(0.581)	
(> 51)	-0.938***	0.542*	Comarca Emberá	-2.838***	
	(0.163)	(0.321)		(1.079)	
Education			comerca Ngobe Bugle	-1.395***	
				(0.360)	
None education	-0.711***	-0.0840			
	(0.131)	(0.565)	Constant	-1.436***	-10.81***
Secondary	0.439***	0.915***		(0.233)	(0.658)
	(0.0837)	(0.218)			
Technical	0.772**	1.277***	Observations	6,627	5,932
	(0.306)	(0.397)	*Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1*		
Professional	1.110***	2.019***			
	(0.150)	(0.165)			
Household characteristics					
Household size	0.579***	0.593***			
	(0.0297)	(0.0461)			
Total children	-0.638***	-0.437***			
	(0.0471)	(0.0816)			
Total elderly people	-0.446***	-0.259**			
	(0.0634)	(0.108)			
Employment	0.347***	0.146			
	(0.0866)	(0.163)			
Geographical conditions					
Rural zone	-0.473***	-2.054***			
	(0.0854)	(0.238)			

Table 30: Goodness-of-fit measure for mobile phone estimation

Sensitivity	Pr(+ D)	90.96%
Specificity	Pr(-~D)	56.23%
Positive predictive value	Pr(D +)	82.32%
Negative predictive value	Pr(~D -)	73.53%
False + rate for true ~D	Pr(+~D)	43.77%
False - rate for true D	Pr(- D)	9.04%
False + rate for classified +	Pr(~D +)	17.68%
False - rate for classified -	Pr(D -)	26.47%
Correctly classified		80.25%

Table 31: Goodness-of-fit measure for fixed internet estimation

Sensitivity	Pr(+ D)	34.52%
Specificity	Pr(-~D)	97.53%
Positive predictive value	Pr(D +)	60.71%
Negative predictive value	Pr(~D -)	93.08%
False + rate for true ~D	Pr(+~D)	2.47%
False - rate for true D	Pr(- D)	65.48%
False + rate for classified +	Pr(~D +)	39.29%
False - rate for classified -	Pr(D -)	6.92%
Correctly classified		91.25%

Table 32: Provinces average log consumption per capita

Province	Mean (Log consumption per capita)
Bocas del toro	2444.2
Coclé	2068.0
Colón	2608.2
Chiriquí	2860.5
Darién	1539.3
Herrera	2526.1
Los Santos	2568.3
Panamá	3998.3
Veraguas	1833.2
Comarca Kuna Yala	775.3
Comarca Emberá	969.8
Comarca Ngöbe bugle	380.4

Source Encuesta de Niveles de Vida 2008, Authors calculations

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