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THE ROLE OF THE DIGITAL ECONOMY IN THE ECONOMIC RECOVERY OF LATIN AMERICA AND THE CARIBBEAN

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EXECUTIVE SUMMARY

The COVID-19 pandemic has resulted in a global economic recession of unprecedented proportions, with one of the greatest impacts in Latin America and the Caribbean.

- In 2020, real Gross Domestic Product (GDP) contracted by 3.1% on a global scale, generating company closures and increases in unemployment around the world, although its impact varied greatly depending on the region.[1]

- Latin America has been the region most affected by the economic contraction (GDP fell by 7% in 2020), while the region's growth in 2021 was marginally higher than the world average and lower in 2022.

- It is worth mentioning that, in general, Latin American countries have suffered stricter confinements than most countries in the world, which partly explains the severity of the contraction of the regional economy.

- However, the impact on the region has varied: while some countries have recorded GDP declines of more than 10% in 2020 (Peru or Panama), others have barely felt the recession, such as Paraguay (-0.6%) or Guatemala (-1.5%).

- This highlights not only the level of advancement of the virus and the weakness of the health systems, but also a vulnerable economic structure, with difficulties to keep the economies functioning in an emergency context.

- To mitigate the economic crisis and accelerate the recovery, the region has an opportunity by leveraging digitization and developing the digital economy.

- Empirical evidence indicates that those countries with greater deployment of broadband networks have been more capable to mitigate the disruptive economic impact of the pandemic. Until 2020, countries with at least 30% of households having adopted fixed broadband (or with more than 50% penetration of unique mobile broadband users) experienced a recession of lesser magnitude than less connected economies.[2] This increased economic resilience is based on the improved capacity to support telecommuting, manage supply chains, virtualize public services such as education, and provide telemedicine.

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[1] International Monetary Fund (2021). *World Economic Outlook: Recovery during a Pandemic-Health Concerns, Supply Disruptions, Price Pressures*. Washington, DC, October

[2] Katz, R. and Jung, J. (2021). *The role of ICT infrastructure in increasing the economic resilience of countries facing pandemics. Katz, R., Jung, J. and Callorda, F. (2020). COVID-19 and the economic value of Wi-Fi. New York: Telecom Advisory Services. downloaded from: https://www.wi-fi.org/download.php?file=/sites/default/files/private/COVID-19_Economic_Value_Wi-Fi_202012.pdf*

Beyond the contribution of digitization to face the pandemic, its impact on GDP, productivity and job creation under normal conditions is significant, making it a key factor in the future economic recovery of the region.

- Structural econometric models developed in the context of this study with panel data from Latin America and the Caribbean indicate that a 10% increase in fixed broadband penetration (from 56.6% of households to 62.2%) is associated with a growth in GDP per capita of 1.47%, while a 10% increase in the penetration of unique mobile broadband users (from 56.8% of individuals to 62.5%) results in a growth in GDP per capita of 1.7%. This implies that the 2020 prorated GDP per capita of USD 7,202 could increase to USD 7,433[3] if both targets (10% increase in fixed and mobile penetration) are met. At the aggregate level, the region's GDP was USD 4,328.4 billion in 2020, which would grow to USD 4,467.2 billion (an increase of about USD 139 billion) if the proposed metrics are met.

- Similarly, a 10% increase in the digitization index would allow the region to increase its total factor productivity by 5.7%, thereby reducing the region's productivity gap with the United States. Currently, the region has a total factor productivity equivalent to 54.4% of that of the United States. In other words, given the same amounts of factors of production (capital and labor), the countries in the region can only produce 54.4% of output compared to the United States. With a 10% growth in the digitization index, the productivity gap would improve to 57.6%.

- In addition, a 10% growth in the digitization index of Latin America and the Caribbean will increase employment by 2.4%, which in turn reduces the average unemployment rate in the region from 10.5% to 8.4%. This means the creation of more than 6.5 million new formal jobs, with an implicit contribution to poverty reduction in the region.

- From a social point of view, a 10% increase in mobile broadband penetration would also allow the region to increase its level of financial inclusion by 2.3%. By applying the coefficient to the current level of financial inclusion in the region, it is estimated that this would increase from 38.8 to 39.7 if mobile broadband penetration were to increase by 10%. Although this increase may seem modest, it is important to bear in mind that all financial services are currently in the process of digitization, so it can be expected that this impact will tend to grow in the short term, with the additional impact of digital literacy programs.

The growth in the development of the telecommunications industry and the digital economy, as key factors of the economic recovery, will only occur in the event of a significant increase in telecommunications investments, an acceleration in the pace of innovation, and greater human capital

[3] All estimates presented in this study are in US dollars. The effects specified for fixed and mobile broadband are added for illustrative purposes, without disregarding the fact that they come from independent econometric estimates.

development, for which an appropriate public policy framework must be put in place to facilitate such advances.

- Latin America and the Caribbean invests a prorated USD 33.82 per capita in telecommunications, lower than the world average (USD 51.81) and significantly lower than advanced economies (USD 121.38 in Western Europe and USD 337.09 in North America).[4] Although it is to be expected that the more advanced economies will have higher levels of investment (due to higher per capita income and considerably higher ARPU levels[5]), it is concerning that this gap does not seem to be narrowing over time. This is having an impact on the deployment of advanced technologies and presents an obstacle for telecommunications networks to meet the growth in data traffic (at a rate of 30% since 2017[6]).

- Similarly, the gap that separates Latin America and the Caribbean from OECD countries[7] in terms of innovation dynamics is growing, especially due to the lag in private investment in R&D.

- Finally, while the region's difference with the OECD in terms of human capital production has not changed substantially in the last ten years, the region shows a growing gap in the digital training of the workforce, which again represents a barrier to the digital transformation of production.[8] The lack of digital training affects the development capacity of local digital content industry, which in turn means that many people do not adopt Internet content services because they do not find them attractive, thereby resulting in a vicious circle.

An analysis of the international experience indicates that the acceleration of investment in telecommunications and the advance of the digital economy are conditioned by four types of initiatives in the regulatory, tax and public policy frameworks.

- A modernization of the telecommunications regulatory framework includes, among other initiatives, the granting of convergent licenses, the availability of sufficient amounts of radio spectrum at reasonable prices, the possibility to trade this resource in the secondary market with the acquiescence of the regulator, as well as to carry out its *refarming,* and the definition of the concept of Significant Market Power based on criteria that go beyond a simple market share.[9]

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[4] Source: ITU, GSMA Intelligence, Telecom Advisory Services analysis.

[5] Acronym for Average Revenue per User.

[6] CISCO (2021). *Annual Internet Report*. Downloaded from: https://www.cisco.com/c/en/us/solutions/executive-perspectives/annual-internet-report/index.html

[7] The OECD average includes the Latin American countries that are part of this group.

[8] Katz, R. L., Berry, T., & Jung, J. (2021, September 30). *Diagnosis of current and future worker needs for the digital technologies sector in Panama.* Caracas: CAF. Downloaded from: http://scioteca.caf.com/handle/123456789/1796

[9] Other criteria that may influence market power are geography, control of essential facilities, access to financial resources, and economies of scale. In turn, a modern regulatory approach should

- Of the aforementioned elements, the case of the radio-frequency spectrum is particularly noteworthy, firstly, due to the lack of assigned amounts of this resource (far from ITU recommendations). Secondly, spectrum prices in the region are considerably higher than in other more digitally advanced nations. On average, the cost of spectrum in Latin America is 1.7 times higher than in Europe[10] . Empirical evidence shows that when state revenue is prioritized in the management of the spectrum, network deployment can be seriously compromised. Alternatively, a 1% reduction in spectrum license payments is associated with a 0.45% increase in 4G coverage in developing countries.[11] In this context, a 50% reduction in the cost of this resource is recomended for those countries in the region with the highest prices and a 25% reduction for the remaining nations. The benefits of reducing the cost of the spectrum are very significant, both directly (greater investment and adoption of services) and indirectly (through GDP growth associated with greater penetration). A higher penetration of telecommunications services and the associated GDP growth will generate increases in tax revenues that could compensate for what the state does not collect by lowering the cost of the spectrum.

- The implementation of a balanced tax and contribution framework should include imposing a limit of regulatory fees to a maximum of 0.5% of revenues, a contribution to the universal service fund (USF) of no more than 1% of revenues, the elimination of specific telecommunications taxes, and the elimination of import tariffs on equipment such as fiber optics, cabling, and consumer devices such as smartphones. Beyond the reduced contribution to the USF, collected funds should be used in the sector, in an agile and transparent process with a clear emphasis on reducing the coverage gap in rural areas. If funds are not invested, it would be desirable to reduce the obligatory contribution until the effective use of these resources takes place.

- The introduction of policies to reduce piracy of online and audiovisual content in subscription television is important to stimulate investment in the development of local content, the consequent reduction of cable TV service pricing and of the associated Internet access.

- The understanding that moderate competition in telecommunications, as opposed to a model of unrestricted competition, is the framework represents a proper incentive to capital investment, guaranteeing an adequate level of investment and innovation.

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periodically review market boundaries since, partly due to convergence, markets may be transformed as a result of the emergence of services provided from different platforms, but which may be substitutes in the eyes of users.

[10] Another relevant aspect in the region is the cost of electricity (price per MW), which is essential for rural access and whose cost is high in several countries.

[11] Bahia, K., & Castells, P. (2021). The impact of spectrum assignment policies on consumer welfare. *Telecommunications Policy*, 102228.

According to simulation models conducted in this study, the economic impact of these recommendations, if implemented, will make a significant contribution to the economic recovery of the region.

- Regulatory modernization will generate an increase in cumulative mobile capital investment[12] over a five-year period of between 166.9% and 3.9%, depending on how aligned a country already is with the recommended initiatives. This leads to an increase of between 39% and 1.1% in coverage and consequently in the range of 8.21% and 0.3% in mobile broadband penetration. Based on the economic impact of broadband penetration, this would result in an increase of between 1.62% and 0.04% on GDP per capita. Among the regulatory measures, the potential generated by the reduction in spectrum prices is particularly noteworthy, as it implies the availability of resources that could be quickly invested.

- The implementation of a balanced tax framework, in accordance with the best practices of international experience, generates a significant impact (over 25%) on cumulative mobile capital investment over a five-year period in those countries with a high tax burden in the telecommunications sector. In countries with lower taxation, the impact on investment will be between 4.7% and 2.4%. As in the previous case, the higher the investment, the greater the mobile network coverage, while a reduction in the tax burden on consumers improves the affordability of the service, thus increasing the adoption of mobile broadband, and with it the GDP per capita (between 7.64% and 0.02%).

- Piracy is causing severe damage to companies and governments in the region. At the Latin American level, the loss of TV providers' revenues is estimated at US$4.8 billion in 2018; in the case of programmers, revenue loss reaches US$1.8 billion, with the combined disappearing of 48,500 jobs. As a result, the region's governments are losing USD 1.1 billion a year in tax revenues.[13] If the countries in the region are successful in combating piracy, it is expected that the supply and diversity of local audiovisual content will increase due to increased investment in local production. For a country with a high level of piracy, implementing policies to reduce piracy could result in a 34.3% increase in audiovisual production and an 18.8% increase in pay TV penetration.

- Recognition of the concept of moderate competition in telecommunications may lead to the consolidation of markets that currently have many operators. Given the nature of the sector, with large economies of scale and sunk costs, telecommunications markets capable of generating strong static and dynamic efficiencies typically have no more than three mobile operators with network infrastructure. An additional element to consider when determining the appropriate number of operators is the size of the market, since a three-operator industry may not be optimal in very small countries.

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[12] The available data only allow us to estimate the impact on the capital investment of mobile operators.

[13] Source: Alliance Against Piracy (2018)

Given the socioeconomic relevance of the telecommunications sector in Latin America, the region needs to reformulate its regulatory and fiscal frameworks to accelerate the deployment of telecommunications networks and the development of the digital economy.

- Naturally, priorities may vary by country, depending on the current situation and which reform presents the greatest opportunity for growth in the sector. This is because the starting point of reform in each country is very different, where some of the recommended good practices are already being fulfilled in some, while in others the reforms will have to go into greater depth.

- Among the regulatory measures, the most urgent aspect to be addressed is that of the radio frequency spectrum, given that there are currently insufficient amounts of this resource available, and their cost remains very high (both in terms of upfront and recurring payments). This situation limits the financial capacity of operators to invest in networks. The operators' financial capacity is also limited by the social or coverage obligations imposed when assigning spectrum. The reduction in spectrum prices is what generates the greatest stimulus to investment. On the other hand, tax reforms can be very effective in increasing penetration (and therefore GDP).

- Finally, the examination of the structure of telecommunications markets with a view to generating long-term sustainable competition and the control of content piracy are two unavoidable conditions for most of the countries in the region.

1. INTRODUCTION

Over the last thirty years, advances in telecommunications and digitization have generated numerous studies analyzing their economic and social impact.[14] In addition, in the last two years, the outbreak of the COVID-19 pandemic has highlighted - even more, if possible - the importance of digitization in terms of its socioeconomic effects, being a key tool to keep the economy and social interactions running, and somehow mitigating the effects of isolation. [15]

For Latin America, the issue takes on special relevance as the region of the world most affected by the economic crisis caused by the pandemic. If we add to this the fact that the region's economy exhibits long-standing structural weaknesses, and that there is still a significant digital divide to close, there is no doubt that the future of prosperity in the region necessarily depends on the acceleration of digitization as a factor of recovery. Recognizing that there is a causal relationship between public policies, regulatory framework as well as taxation, and the performance of the sector[16] , Latin America needs to consider changes in the regulatory and fiscal frameworks in order to accelerate the deployment of telecommunications networks and the development of the digital economy.

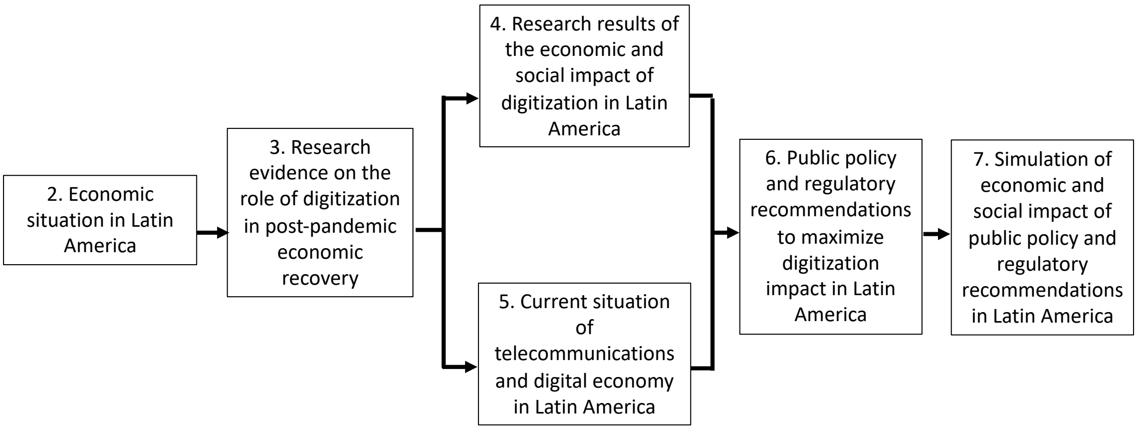
To this end, it is important to establish a theoretical framework substantiated by rigorous empirical analysis that will help public policy makers in the region to strengthen the conditions for the development of digitization, making them respond to the interests of economic and social development in the region and focus on the process of economic recovery in a post-pandemic scenario. In consideration of the above, the objectives of this study are the following:

- Compile the most recent indicators of telecommunications adoption and digitization development.
- Estimate, based on econometric studies, their economic impact (growth of Gross Domestic Product (GDP) per capita, increase in total factor productivity, generation of employment, and increase in financial inclusion).
- Identify, based on the best international regulatory practices, the main reforms that the countries of the region should carry out and their impact on the development of the sector.
- To know the status of telecommunications taxation in Latin America (what taxes are applied in the different countries of the region, which goods and services are taxed, etc.), and to estimate the possible impact of changes in the taxation framework.

The analytical structure of this study is organized around six central chapters (see Figure 1-1).

[14] Footnote 19 in Chapter 3 presents citations from the research literature.
[15] Footnote 20 to 24 of Chapter 3 presents citations from the research literature.
[16] Footnote 52 in Chapter 6 presents citations from the research literature on this topic.

Figure 1-1. General study framework

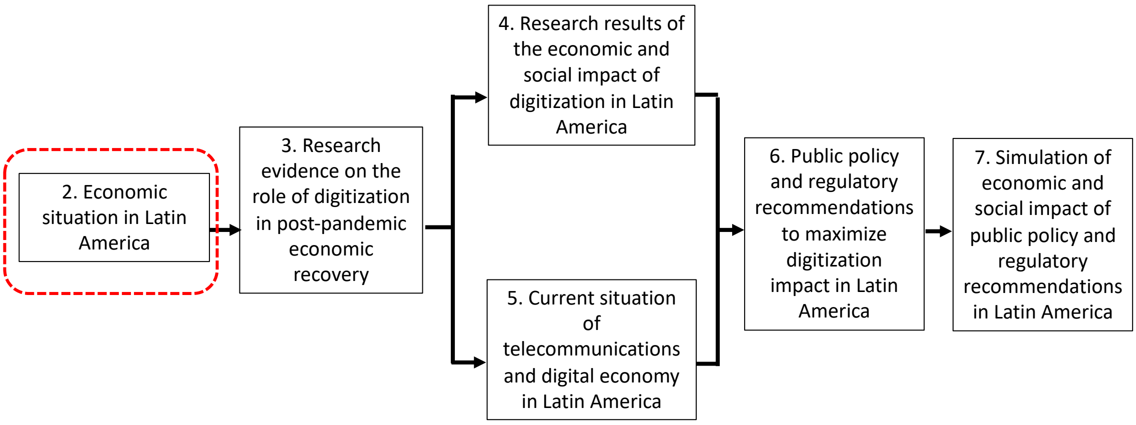


Chapter 2 presents a series of indicators on the economic situation in Latin America since irruption of the COVID-19 pandemic. Chapter 3 analyzes, based on the specialized literature, the role of telecommunications and digitization as an opportunity for economic recovery. Chapter 4 presents the results of the empirical research conducted as part of this study on the economic and social impact of digitization in Latin America. In this regard, we study the impact of broadband in terms of per capita GDP growth, and of digitization on total factor productivity growth, employment generation, and increased financial inclusion. Based on the results of Chapter 4, Chapter 5 analyzes the current situation in Latin America and the Caribbean in terms of advances and barriers in development of telecommunications and the digital economy. Chapter 6 presents, based on the international experience, recommendations of change in the regulatory and tax frameworks, control of content piracy and migration to efficient market structures aimed at maximizing the development of telecommunications and digitization in the region. Finally, Chapter 7 presents simulations carried out in this study, estimating the socioeconomic impact resulting from the implementation of these recommendations.

2. ECONOMIC SITUATION IN LATIN AMERICA AS A RESULT OF COVID-19

The following chapter analyzes the economic situation in Latin America since the COVID-19 pandemic. The purpose is to generate a baseline from which the potential economic impact of telecommunications and the digital economy can be considered within a recovery path (see Figure 2-1).

Figure 2-1. General study framework

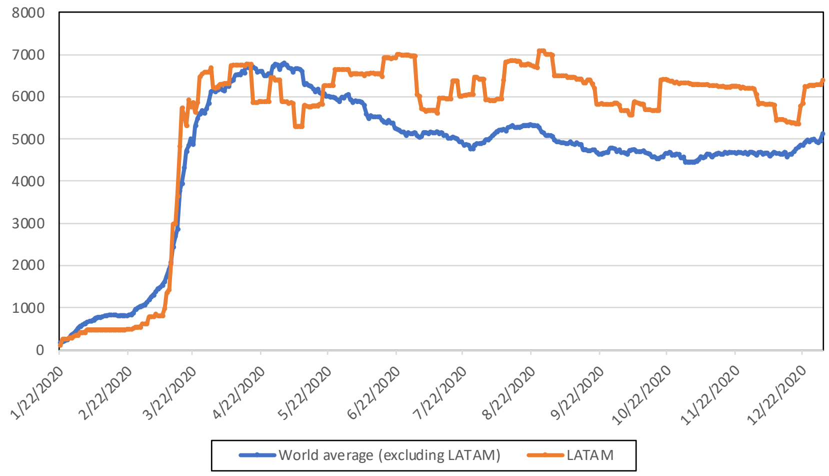


The COVID-19 pandemic has generated a global economic recession of little precedent. In the year 2020, real GDP contracted by 3.1% on a global scale, generating business closures and increases in unemployment around the world, although its incidence varied greatly depending on the region. This is explained by the different intensity of virus infections, the various strategies implemented for dealing with it, the disparities in vaccination programs and, in addition to all this, the structural differences of each economy.

In Latin America, the pandemic has severely affected the performance of the daily routines of its population. The *Stringency Index* published by *Our World in Data*[17] , which measures the level of closure of economic activity in response to the pandemic, including school and office closures, as well as travel bans, among other measures, indicates that the severity of the confinements in the region was similar to the rest of the world until May 2020. However, since that date, and until the end of that year, the restrictions in the region have been considerably harsher than the world average (Graph 1-1). Likewise, in the year 2021, some restrictions that affected the daily activity of the population remained in place.

[17] The COVID-19 *Stringency Index* is a composite index based on six measures taken by a nation in the face of the pandemic, including school holidays, workplace closures, travel bans, among others. Each indicator is measured between 0-100. Data source is from the Oxford COVID-19 Government Response Tracker. Blavatnik School of Government, University of Oxford.

Graph 2-1. Latin America vs. world average: *Stringency* Index



Source: Our World in Data

The harshness of restrictions has severely affected the region's economic performance, when measured in terms of the contraction of gross domestic product. As evidenced in Table 2-1, the virus has hit the economies of two regions the hardest in 2020: the Eurozone (-6.3%) and Latin America and the Caribbean (-7%). In contrast, in Asia, the Middle East, Africa and emerging Europe, the economic crisis has been of a lesser magnitude. Within Latin America, the effects of the crisis have been uneven: while some countries have recorded GDP declines of more than 10% in 2020 (as in the case of Peru and Panama), others have barely felt the recession, such as Paraguay (-0.6%) and Guatemala (-1.5%).

Table 2-1. Real GDP growth rate - by region

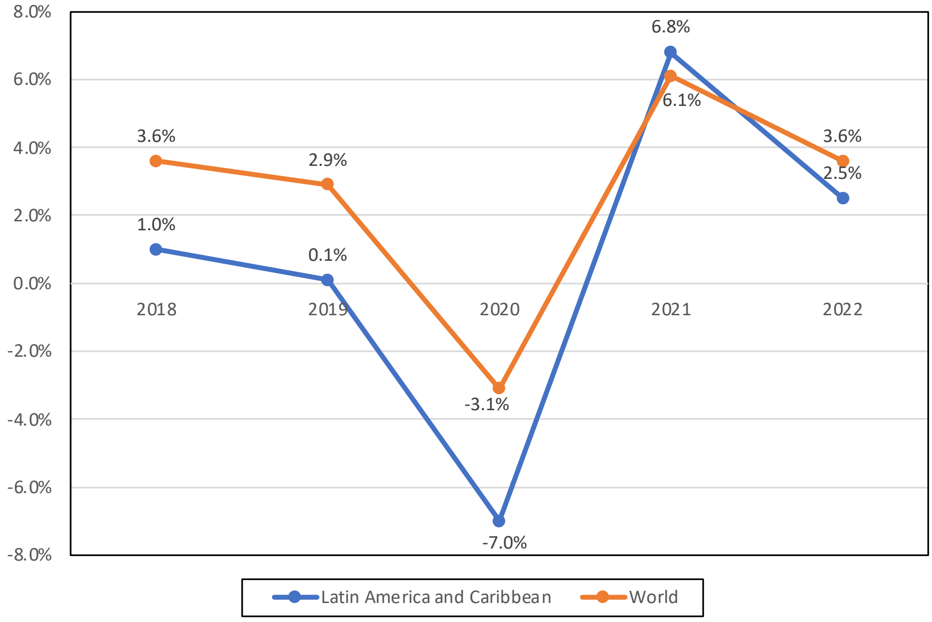
Region	2018	2019		2021	2022
United States	2.9%	2.3%	-3.4%	6.0%	5.2%
Eurozone	1.9%	1.2%	-6.3%	5.0%	4.3%
Asia (emerging)	6.4%	5.5%	-0.8%	7.2%	6.3%
Europe (emerging)	3.1%	2.1%	-2.0%	6.0%	3.6%
Latin America and Caribbean	1.0%	0.1%	-7.0%	6.8%	2.5%
Argentina	-2.6%	-2.1%	-9.9%	7.5%	2.5%
Bolivia	4.2%	2.2%	-8.8%	5.0%	4.0%
Brazil	1.8%	1.4%	-4.1%	5.2%	1.5%
Chile	3.7%	1.0%	-5.9%	11.0%	2.5%
Colombia	2.6%	3.3%	-6.8%	7.6%	3.8%
Costa Rica	2.6%	2.3%	-4.1%	3.9%	3.5%
Ecuador	1.3%	0.0%	-7.8%	2.8%	3.5%
El Salvador	2.4%	2.6%	-7.9%	9.0%	3.5%
Guatemala	3.3%	3.9%	-1.5%	8%	4.0%
Honduras	3.9%	2.7%	-9.0%	12.5%	3.8%
Mexico	2.2%	-0.2%	-8.3%	6.3%	4.0%
Nicaragua	-3.4%	-3.7%	-2.0%	5.0%	3.5%
Panama	3.6%	3.0%	-18.0%	12.0%	5.0%
Paraguay	3.2%	-0.4%	-0.6%	4.5%	3.8%
Peru	4.0%	2.2%	-11.0%	10.0%	4.6%
Uruguay	0.5%	0.4%	-5.9%	3.1%	3.2%
Middle East and Central Asia	1.9%	1.2%	-2.8%	4.1%	4.1%
Sub-Saharan Africa	3.2%	3.1%	-1.7%	3.7%	3.8%

Source: International Monetary Fund

The fact that Latin America has been the most affected region because of the economic crisis generated by the pandemic highlights not only the level of contagion of the virus and the weakness of its health systems, but also a vulnerable economic structure, with difficulties to remain operating in an emergency context. It should be recalled that the region's economy had already been growing at very modest levels in 2018 and 2019, compared to the other regions, with 2019 being a year of stagnation (0.1%). On the other hand, the recovery expected for 2021 and 2022, according to International Monetary Fund (IMF) forecasts[18] , will be significant in 2021 (6.8%, although to a lesser extent than emerging Asia, 7%), but positioning Latin America as the region with the lowest growth in 2022 (2.5%). This forecast suggests significant structural economic weaknesses beyond the impact of the pandemic.

As shown in Graph 2-2, only during 2021 will the region's growth be higher (by a very small margin) than the world average. High growth rates in 2021 stand out for Chile (11%), Panama (12%) and Peru (10%). In all the other years surveyed, the Latin American economy has grown or will grow at a slower pace than the rest of the world. It is worth noting that, within the region, only Panama is expected to grow above the world average in 2022.

Graph 2-2. Real GDP Growth Rate - Latin America vs. world average



Source: International Monetary Fund

The IMF forecasts that the region's GDP will only recover to 2019 levels by 2022.

Beyond GDP growth, other indicators show the magnitude of the crisis of 2020. For example, international trade has contracted considerably (Table 2-2), registering significant reductions in the volume of exports and imports worldwide (-7.8% and -8%, respectively, between January and August 2020). In Latin America and the

[18] International Monetary Fund (2021). *World Economic Outlook: Recovery during a Pandemic-Health Concerns, Supply Disruptions, Price Pressures*. Washington, DC, October

Caribbean especially, the contraction in cross-border trade has mainly affected imports from the rest of the world (-14.7%), a figure only matched by that experienced by emerging Asia.

Within the region, the volume of exports has fallen sharply during 2020 in Argentina, Bolivia, Dominican Republic, El Salvador, Honduras, Panama, Peru and Uruguay, with all of these countries registering a contraction of more than 10%. Something similar can be said about imports during 2020 in Argentina, Bolivia, Chile, Colombia, Ecuador, Mexico, and Venezuela. In Brazil, on the other hand, the change in trade volume has been minimal (see details by country in Annexes 1 and 2).

Table 2-2. Change in the volume of international trade with respect to the same period of the previous year

Region	January-August 2020		January-August 2021	
	Exports	Imports	Exports	Imports
World	-7.8%	-8.0%	12%	11%
Advanced economies	-9.7%	-8.8%	12%	10%
China	-1.9%	3.0%	27%	12%
Asia (emerging)	-7.3%	-14.2%	18%	21%
Eastern Europe	1.7%	-7.9%		11%
Latin America and Caribbean	-5.7%	-14.7%	8%*	20%*
Africa and Middle East	-5.4%	-2.7%	-2%	

Note: (*) January to December
Sources: ECLAC (2020). Prospects for International Trade in Latin America and the Caribbean: regional integration is key to recovery after the crisis. Santiago and ECLAC (2021). *Prospects for International Trade in Latin America and the Caribbean: in search of a resilient and sustainable recovery.*
ECLAC (2022). Preliminary Overview of the Economies of Latin America and the Caribbean, 2021 (LC/PUB.2022/1-P), Santiago, 2022.

After a significant decline in 2020, world trade volume has seen a significant recovery in 2021, because of the gradual lifting of mobility restrictions, progress in the vaccination processes, and the economic stimulus programs adopted. World exports have grown by 12% and imports by 11% in the period between January and August 2021, compared to the same period of the previous year. The expansion of exports from Latin America and the Caribbean (8% between January and December 2021) was lower than the world average, while the growth in the volume of its imports doubled that average (20%), in the context of the recovery of economic activity in the region. According to ECLAC[19] , the terms of trade in 2021 will improve for hydrocarbon exporting countries, followed by agro-industrial and mining exporters. On the other hand, the terms of trade of those economies that are highly dependent on imports of fuels and other raw materials, such as many Central American countries, are expected to deteriorate.

However, looking ahead and as will be argued in this study, regardless of structural changes in the terms of trade, the growth of international trade in Latin America and

[19] ECLAC (2021). *Prospects for International Trade in Latin America and the Caribbean. In search of a resilient and sustainable recovery*, Santiago, Chile.

the Caribbean and its contribution to the recovery is linked to an acceleration in the rate of digital transformation of production.

The economic crisis generated by the pandemic has also generated profound social effects in the region, according to a recent ECLAC study (2022)[20] . Even after the recovery process started in 2021, the social crisis persists, which manifests itself in high unemployment rates and levels of poverty and extreme poverty higher than those observed before the pandemic. The loss of employment and the reduction of labor income have especially affected the lower income strata, women, and young people, which has exacerbated the region's structural problems, increasing inequality. In the case of young people, it not only destroys employment, but also interrupts education and training and poses major obstacles to finding a first job. In 2021, the extreme poverty rate in the region reached 13.8% while the poverty rate would amount to 32.1%, placing it above 2019 levels despite the economic recovery. This situation, coupled with high levels of uncertainty, highlights that the impact of the COVID-19 pandemic is far from over.

Within the region, the pandemic has had a very disparate economic impact, with some countries experiencing a contraction well above average, while others have been barely affected. The following is a brief description of the main economies in the region, based on data from the IMF[21] and local sources:

- In Argentina, the pandemic has resulted in a recession of -9.9% of the GDP in 2020. A significant recovery is expected in 2021 (7.5%), and to a lesser extent, in 2022 (2.5%)[22] . The current account balance was positive in 2020 and will continue at similar levels in the coming years, largely due to the depreciation of the Argentine peso. Unemployment, which reached 11.6% in 2020, will only fall to single-digit levels in 2022 (projected 9.2%).

- Bolivia has registered a significant contraction in 2020 (-8.8%), compensated by a 5% growth in 2021[23] , which will decelerate to 4% by 2022[24] . In turn, the current account balance recorded a negative balance in 2020, and given the better international prices, it had a small positive balance in 2021, but would deteriorate in the following years as a function of the normalization of commodity prices. Unemployment fell from 8.3% in 2020 to 5.2% in 2021[25], as the drop in household income (more than 10% compared to the pre-pandemic situation) prompted several people to enter the labor market.

- The Brazilian economy experienced a contraction of 4.1% in 2020, with a recovery expected in 2021 and 2022 (growth projections of 5.2% and 1.5%,

[20] ECLAC (2022). *Social Panorama of Latin America*, 2021 (LC/PUB.2021/17-P), Santiago, 2022.
[21] International Monetary Fund (2021). *World Economic Outlook: Recovery during a Pandemic-Health Concerns, Supply Disruptions, Price Pressures*. Washington, DC, October
[22] Updated to 10.2% and 4% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[23] The Bolivian Center for Economic Studies (CEBEC) estimates growth of 6% in 2021.
[24] Updated to 6.1% and 3.8% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[25] Source: Bolivian Center for Economic Studies (CEBEC)

respectively)[26] . The unemployment rate, which rose to 13.5% in 2020, will only begin to fall in 2022, albeit slowly (projected at 13.1%). The current account balance will remain negative, although a reduction in its deficit is expected by 2021.

- In Chile, the recession has been of lesser magnitude than the regional average during 2020 (-5.9%), and very strong growth is forecast for 2021 (11%)[27] . The current account balance, which had recorded a positive balance in the year of the pandemic, will turn negative in 2021 and 2022 driven by the recovery of imports. Unemployment, which reached 10.8% in 2020, will fall to 7.4% in 2022.

- In Colombia, the economy contracted by 6.8% during 2020. A strong recovery was registered in 2021 (7.6% for the IMF, 9.9% according to the latest World Bank update[28]), followed by significant growth of 3.8% in 2022[29] . Unemployment reached a high of 16.1% during the pandemic, and while it is projected to decline, it will remain at high levels (13.8% in 2022).

- Costa Rica has recorded a GDP decline lower than the regional average in 2020 (-4.1%), with a recovery of around 4% expected for the next two years (3.5% growth is forecast for 2022)[30] . Although the current account balance will remain negative, it is worth noting that a significant growth in the volume of exports was achieved in 2021 (28%). The unemployment rate has been very high in 2020 (20%[31]) but is expected to fall to 14% in 2022.

- In Ecuador, GDP contracted by 7.8% in 2020, and grew by 2.8% in 2021[32] . The trade balance has turned positive since the COVID crisis, mainly due to the sharp drop in imports, which fell by more than 14% in volume. The unemployment rate stood at 5.3% in 2020, and fell to 4.6% in 2021 with the economic recovery.

- In El Salvador, the GDP contracted by about 8% in 2020, although a very strong recovery was achieved in 2021 (9%)[33] , projected to decline to 3.5% in 2022. The current account balance has turned positive in the year of the pandemic, although it will return to a negative balance in 2021 because imports will grow more than exports (in volume, the former will grow 17.6%,

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[26] Updated to 4.6% and 0.8% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[27] Updated to 11.7% according to the latest IMF estimate (April 2022).
[28] El Tiempo (2022). Colombia grew 4 points more than projected by the World Bank (January 12). Available at: https://www.eltiempo.com/economia/sectores/banco-mundial-estimaciones-de-crecimiento-en-colombia-en-2021-644144
[29] Updated to 10.6% and 5.8% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[30] Updated to 7.6% and 3.3% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[31] 21.3% as of December of that year
[32] Updated to 4.2% according to the latest IMF estimate (April 2022).
[33] The local Central Bank has estimated an 11.3% growth of the economy as of the third quarter of 2021. The IMF recently updated the figures to 10.3% and 3% for 2021 and 2022, respectively.

while the latter 15.1%). Interestingly, the IMF projects an increase in the unemployment rate to 9.5% in 2021 from 8.7% in 2020. This means that the economic recovery will take time to translate into an impact on the labor market. It is not until 2024 that the unemployment rate is expected to return to pre-pandemic levels of around 7%.

- Guatemala has been little affected by the pandemic, with GDP contracting by only 1.5% in 2020, and strong growth levels projected for 2021 and 2022 (5.5%[34] and 4.5%, respectively)[35] . The current account balance improved in the year of the pandemic, because the contraction in the volume of imports was greater than that of exports. However, by 2021, the volume of exports is projected to grow by only 6%, at a slower rate than imports (9.5%). Inflation in 2020 was 4.82%, and in 2021 it was 3.07%, and is projected to reach 4% in 2022 (source: Instituto Nacional de Estadística Guatemala-INE).

- Honduras has registered a significant contraction in 2020 (-9%), with the IMF estimating a strong recovery for 2021 (12.5%) and moderate growth for 2022 (3.8%). Unemployment has reached 6.8% in 2020, and already by 2022 it is expected to be below pre-pandemic levels (5.2%). The current account balance, positive in 2020, will turn negative from 2021 as imports are expected to recover faster than exports.

- In Mexico, real GDP contracted by 8.3% in 2020. A gradual recovery of its economy is expected, with projected growth of 6.3% in 2021 and 4% in 2022[36] . The current account, which was positive in the pandemic year, will balance to a slightly negative value by 2022, due to the recovery of the country's imports. Unemployment has remained at low levels despite the pandemic and is expected to remain at around 4% in the coming years.

- Nicaragua has registered a comparatively small GDP decline in 2020 (-2%), with growth of 5% and 3.5% projected for 2021 and 2022[37] . Despite this, the IMF projects a sharp increase in the unemployment rate by 2021, to 11% from 7.3% in 2020 (according to the Central Bank of Nicaragua, unemployment in 2020 stood at 5%). The unemployment rate is not expected to reach pre-pandemic levels until at least 2024. In the case of the current account balance, a deficit balance was shown in the second and third quarters of 2021, with the evolution for the coming years being uncertain.

- Panama suffered one of the largest recessions in 2020, with real GDP contracting by 18%. Strong growth is expected in 2021 (12%)[38] and a

[34] 7.5% according to the Bank of Guatemala
[35] Updated to 8% and 4% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[36] Updated to 4.8% and 2% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[37] Updated to 10.3% and 3.8% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[38] It is worth mentioning that, according to the local Ministry of Economy and Finance, real GDP growth from January to September 2021 was 14.9% and it is estimated that it could be 15.5% for the whole of that year, higher than the IMF's projection.

stabilization around 5% of real GDP growth until 2024[39] . Due to the sharp contraction in imports, the current account balance has turned positive in 2020, although from 2021 a return to pre-pandemic negative current account trends is expected. Unemployment, very high in 2020 (18.5%), will fall considerably in 2021 to 1.3%.

- In Paraguay, the recession was very mild in 2020 (-0.6%), and the country will grow at rates of 4.5% and 3.8% in 2021 and 2022, respectively[40] . The current account balance will remain positive, and unemployment will hover around 7-8% in the coming years.

- Peru was one of the countries most affected by the pandemic, with a contraction in real GDP of 11%. Growth of 10% is forecast for 2021, followed by 4.6% in 2022[41] . Unemployment will fall sharply hand in hand with the economic recovery, from 13% (2020) to half (6.5%) in 2022. The current account balance will remain in positive balance.

- In Uruguay, the recession was lower than the average for the region, with GDP contracting by 5.9% in 2020, and projected to grow by 3.1% in 2021[42] . The current account balance has turned negative in 2020 as exports have fallen more than imports. The unemployment rate increased to 10.4% in 2020 and remained stable last year.

- Venezuela has been immersed in a severe economic crisis since before the outbreak of the pandemic. GDP has contracted by 30% in 2020, and by 2021 the projected fall was 5%[43] . The country's trade balance, normally positive, turned negative in 2020, due to the sharp contraction in international oil demand (exports fell by 50% in volume that year).

In the context of this situation, it is therefore important to understand what opportunities are opening to maximize Latin America's economic recovery, and digitization is a crucial tool for this purpose. This will increase the contribution of traditional sectors while generating new businesses and opportunities for the region. In short, digital transformation is an essential component of the future of Latin American economies, beyond the post-pandemic recovery.

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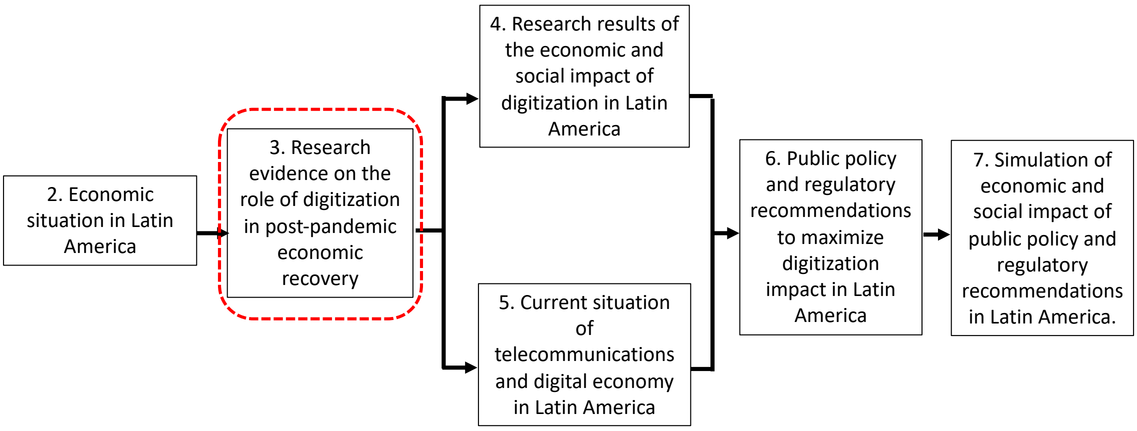
[39] Updated to 15.3% and 7.5% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[40] The projections of the Central Bank and the local Statistical Institute differ slightly: -0.8% in 2020, 5% in 2021 and 3.7% in 2022. The IMF has recently updated its projections to 4.2% and 0.3% for 2021 and 2022, respectively.
[41] Updated to 13.3% and 3% for 2021 and 2022, respectively, according to the latest IMF estimate (April 2022).
[42] Updated to 4.4% according to the latest IMF estimate (April 2022).
[43] Updated to -1.5% according to the latest IMF estimate (April 2022).

3. DIGITIZATION AS A LEVER OF ECONOMIC RECOVERY AFTER THE PANDEMIC

The following chapter provides empirical evidence of the role of digitization in mitigating the negative socioeconomic impact of pandemics such as the current coronavirus (see Figure 3-1).

Figure 3-1. General framework of the study



Beyond the impact that digitization generates under normal conditions on GDP, productivity, and employment levels (widely identified in the specialized literature[44]), it is important to emphasize that the role of digitization becomes even more crucial in a pandemic context, being a driver of economic resilience.

In lockdown situations, broadband connectivity allows citizens to continue performing activities that in the past required physical contact.[45] Tasks such as working remotely from home, shopping online, accessing information online, keeping children in school through digital tools, and socializing and entertainment activities (communication with family and friends, social networks and content

[44] See Katz, R. and Callorda (2020). *The economic contribution of broadband, digitization and ICT regulation and Regional Econometric Modelling*. Geneva: International Telecommunication Union; Hardy, A. (1980). "The role of the telephone in economic development". *Telecommunications Policy*, 4 (4), pp. 278-286; Karner, J., and Onyeji, R. (2007). *Telecom Private Investment and Economic Growth: the case of African and Central & East European Countries*. Jonkoping International Business; Jensen, R. (2007). "The Digital Provide: Information (Technology), Market Performance, and Welfare in the South Indian Fisheries Sector". *Quarterly Journal of Economics*, *122*; Katz, R. L., Zenhäusern, P., and Suter, S. (2008). *An evaluation of socio-economic impact of a fiber network in Switzerland.* Polynomics and Telecom Advisory Services, LLC; Katz, R. (2011). *The economic impact of Vive Digital*. CINTEL: Bogota; Katz, R., and Suter, S. (2009). *Estimating the economic impact of the broadband stimulus plan*. Presentation at the National Press Club, Washington, DC, February 19; Katz, R., Vaterlaus, S., Zenhäusern, P., and Suter, S. (2012). "The Impact of Broadband on Jobs and the German Economy." *Intereconomics*, 45 (1), pp. 26-34; Arvin, M., and Pradhan, R. (2014). "Broadband penetration and economic growth nexus: evidence from cross-country panel data." *Journal of Applied Economics*, Volume 46 -Issue 35.

[45] See Katz, R. and Jung, J. (2021). *The impact of broadband and digitization through the COVID-19 pandemic: Econometric modelling*. Geneva: International Telecommunication Union, Katz, R. and Jung, J. (2021). *The role of ICT infrastructure in increasing the economic resilience of countries facing pandemics.* Katz, R., Callorda, F. and Jung, J. (2020) *Can Digitization Mitigate COVID-19 Damages? Evidence from Developing Countries*.

platforms) would have been very difficult to carry out if the pandemic had occurred a few years earlier, when consumers did not have the quality of digital infrastructures that we enjoy today. At the business level, the digitization of production processes has proven to be critical to keep the economy running during the pandemic. Beyond telecommuting, digitized supply chains and electronic distribution channels can contribute substantially to maintaining the level of production in a context where social contacts must be minimized. At the government level, digitization makes it possible to keep public offices in operation, offering public services and handling requests for procedures online.

Empirical evidence validates the role of digitization in this type of circumstances. Until 2020, most of the empirical studies related to this topic highlighted the role of digitization for emergencies, but not specifically in the case of pandemics. To cite a few examples, Teodorescu (2014) analyzed the role of information technologies in conditions of natural disasters, referring to their capability to contribute to decision making or to keep critical services running.[46] On the other hand, O'Reilly et al (2006) analyzed the role of telecommunications networks in a context of hurricanes affecting the United States, highlighting the possibilities of maintaining emergency services in operation under such circumstances.[47]

As of 2020, new studies have been published that have analyzed the role of digitization in the context of pandemics. Chamola et al (2020) studied the role of technologies such as Internet of Things (IoT), blockchain, artificial intelligence (AI) and 5G, among others, to help mitigate the impact of confinement.[48] Other authors have studied the role of digitization for telemedicine and healthcare (Biancone et al 2021[49] ; Tortorella et al, 2021[50] ; Massaro, 2021[51]).

Regarding the role of digitization in mitigating the economic impact of a pandemic, Katz et al (2020) generated empirical evidence indicating that the economic losses generated by SARS in 2003 were lower in those affected countries with better fixed broadband networks.[52] Specifically, the study found that, after controlling for several variables, the countries affected by that health crisis that had fixed

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[46] Teodorescu HN.L. (2014) Survey of IC&T in Disaster Mitigation and Disaster Situation Management. In: Teodorescu HN., Kirschenbaum A., Cojocaru S., Bruderlein C. (eds) *Improving Disaster Resilience and Mitigation - IT Means and Tools*. NATO Science for Peace and Security Series C: Environmental Security. Springer, Dordrecht.

[47] O'Reilly, G., Jrad, A., Nagarajan, R., Brown, T. and Conrad, S. (2006). Critical Infrastructure Analysis of Telecom for Natural Disasters, *Networks 2006. 12th International Telecommunications Network Strategy and Planning Symposium*, New Delhi, 1-6.

[48] Chamola, V., Hassija, V., Gupta, V. and Guizani, M. (2020). "A Comprehensive Review of the COVID-19 Pandemic and the Role of IoT, Drones, AI, Blockchain, and 5G in Managing its Impact." *IEEE* Access (8): 90225-90265.

[49] Biancone, P., Secinaro, S., Marseglia, R., & Calandra, D. (2021). E-health for the future. Managerial perspectives using a multiple case study approach. *Technovation*, 102406.

[50] Tortorella, G.L., Fogliatto, F.S., Saurin, T.A., Tonetto, L.M., & McFarlane, D. (2021). Contributions of Healthcare 4.0 digital applications to the resilience of healthcare organizations during the COVID-19 outbreak. *Technovation*, 102379.

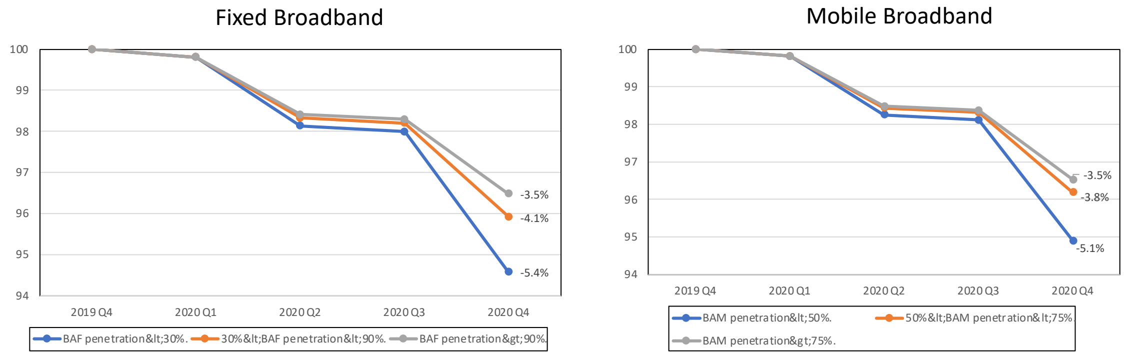
[51] Massaro, M. (2021). Digital transformation in the healthcare sector through blockchain technology. Insights from academic research and business developments. *Technovation*, 102386.

[52] Katz, R., Jung, J., & Callorda, F. (2020c). "Can digitization mitigate the economic damage of a pandemic? Evidence from SARS." *Telecommunications Policy*, *44*(10).

broadband penetration levels above 20% in 2003 did not suffer significant economic losses, when controlling for multiple factors. On the other hand, affected economies with penetration levels below that threshold experienced an economic contraction, which was greater al low levels of connectivity.

More recently, Katz and Jung (2021)[53] analyzed the contribution of digital technologies to increasing the economic resilience of countries in the context of COVID-19, verifying that, *ceteris paribus,* countries with at least 30% of households with fixed broadband (or with 50% penetration of unique mobile broadband users) experienced a recession of lesser magnitude than less connected economies. Furthermore, countries with very high levels of connectivity (fixed broadband penetration above 90%, and mobile broadband unique user penetration above 75%) experienced even smaller economic losses. These levels of resilience were simulated in terms of the GDP impact elasticity of countries experiencing similar levels of COVID contagions and deaths (see Graph 3-1).

Graph 3-1. Simulation of GDP per capita (2019 Q4=100) by broadband penetration level



Source: Katz, R. and Jung, J. (2021). The Economic Impact of Broadband and Digitization through the Covid-19 pandemic - Econometric Modelling. Geneva: International Telecommunications Union.

Specific country examples validate this statement. For example, if we compare two countries with similar characteristics such as Norway and Finland, both have had a similar level of virus incidence during 2020, judging by the prorated deaths per inhabitant. However, Norway's GDP barely contracted in 2020 (-0.77%), while Finland suffered a significant recession (-2.88%)[54] . The two countries differ in the level of connectivity: while Norway has a fixed broadband penetration per household of over 100%, while Finland approaches 73.6%[55] . While there may be other reasons behind the disparate economic performance (such as sector composition of the economy, or the approach chosen to deal with the virus), it is reasonable to think that, unlike the Norwegians, not all Finns have been able to quasi-normal routines in the context of lockdowns.

In short, the presented evidence has highlighted the important role of broadband connectivity and digitization in mitigating the socioeconomic impact of the pandemic. Considering this positive contribution, it is expected that digitization will

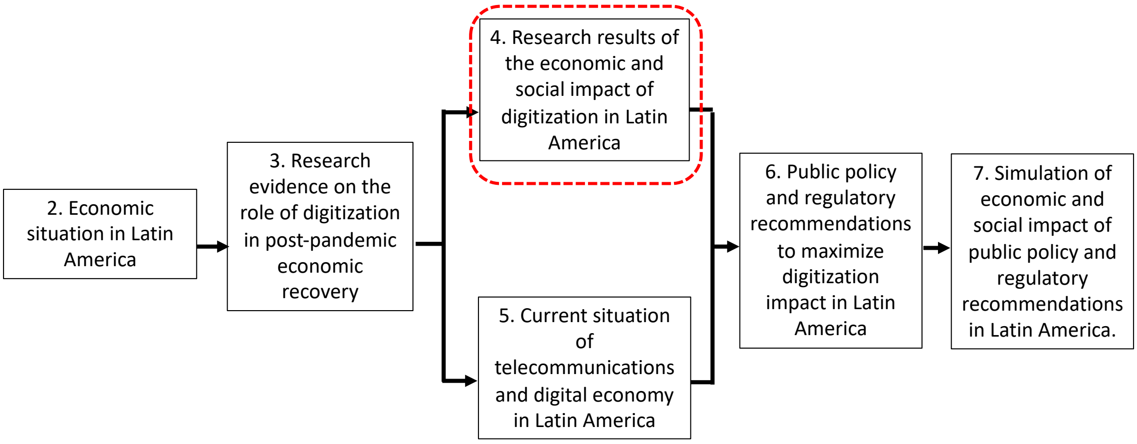
[53] Katz, R. and Jung, J. (2021). *The Economic Impact of Broadband and Digitization through the Covid-19 pandemic - Econometric Modelling*. Geneva: International Telecommunications Union.
[54] Data from the International Monetary Fund
[55] Source: ITU, Telecom Advisory Services analysis

play a crucial role in the coming years for the recovery of Latin America. In this context, it is urgent to take measures to encourage investment in telecommunications and the deployment of digital technologies in the region. Before providing recommendations to that effect, we will analyze the contribution of digitization to the Latin American economies.

4. ECONOMIC IMPACT OF DIGITIZATION

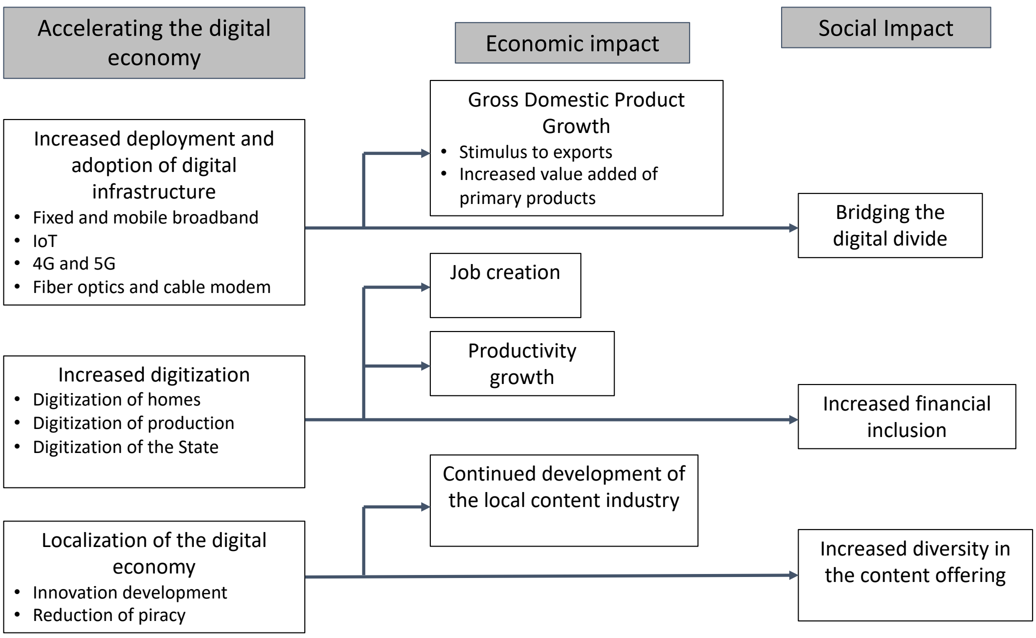
The purpose of this chapter is to present results of empirical research on the economic and social impact of digitization in Latin America and the Caribbean conducted with statistical series through 2020. This provides the basis for determining the economic impact of the public policy, regulatory and taxation recommendations to be presented in chapter seven of this study (see figure 4-1).

Figure 4-1. General framework of the study



In general terms, the deployment and adoption of connectivity infrastructure generates an economic contribution (GDP growth), as well as a social impact due to the reduction of the digital divide. Beyond these effects, digitization in a broader sense (defined as the use of technology in households, businesses, and the state) contributes to job creation and productivity (economic impact), and to other aspects that can be associated with social impact (e.g., increasing financial inclusion of vulnerable sectors). All these causal relationships are depicted in Figure 4-2.

Figure 4-2. Economic and social impact of digitization



Source: Telecom Advisory Services

Considering all the possibilities of economic and social impact set out in Figure 4-2, the causal mechanisms of these impacts are analyzed and quantified to be able to measure more precisely the potential of digitization for Latin America.

4.1. The economic contribution of fixed and mobile broadband

The purpose of this section is to estimate the impact of fixed and mobile broadband on GDP per capita using econometric models for Latin America. For econometric model specification, ITU data for fixed broadband and GSMA Intelligence data for mobile broadband are used.[56] To do so, we begin by presenting the current situation in terms of adoption, and then theoretically detail the channels of socioeconomic impact, concluding with an estimation of the contribution based on econometric models.

4.1.1. The current situation of fixed and mobile broadband in Latin America and the Caribbean

As shown in Table 4-1, Latin America and the Caribbean has fixed broadband penetration levels in terms of percentage of household adoption (56.47%) slightly below the world average (58.33%).

Table 4-1. Comparative fixed broadband penetration (% of households)

Region	2019	2020	Delta
World	54.72 %	58.33 %	6.6 %
Sub-Saharan Africa	3.46 %	4.11 %	18.8 %
Latin America and the Caribbean	51.38 %	56.47 %	9.9 %
Asia and Pacific	53.76 %	57.50 %	6.9 %
Arab States	62.90 %	70.63 %	12.3 %
Western Europe	91.34 %	95.09 %	4.1 %
Eastern Europe	63.28 %	66.11 %	4.5 %
North America	91.99 %	96.20 %	4.6 %

Sources: ITU; national regulators; operator information; Telecom Advisory Services analysis.

This situation, however, leaves Latin America far behind the most advanced economies: the percentage of connected households in Western Europe and North America exceeds 95%. As expected, growth of broadband penetration between 2019 and 2020 was higher in the region than the global average. This is so because advanced economies at high stage of connectivity should have low growth rates. However, Latin America's connectivity growth is below that of other emerging regions, even if they are more connected (as is the case of the Arab States). At any rate, considering that nearly 44% of Latin American households do not have a fixed broadband connection, the region needs to accelerate the connectivity growth rate to close the digital divide. According to estimates by the Inter-American Development Bank (Brichetti et al, 2021), the investments needed in the

[56] Although the definition of broadband may vary by country, the ITU defines it as those connections with a minimum speed of 256 kbps.

telecommunications sector for the region to meet the targets of the Sustainable Development Goals by 2030 amount to USD 293,675 million[57] .

As for mobile broadband (Table 4-2), penetration levels in Latin America and the Caribbean (in terms of unique users) are slightly above the world average, with a total of 56.82% in 2020 (the world average is 54.34%).

Table 4-2. Comparative mobile broadband penetration (Unique users[58] , % of population)

Region	2019		Delta
World	51.78 %	54.34 %	4.9 %
Sub-Saharan Africa	28.69 %	31.27 %	9.0 %
Latin America and the Caribbean	54.74 %	56.82 %	3.8%
Asia and Pacific	48.98 %	52.07 %	6.3 %
Arab States	48.77 %	50.84 %	4.3 %
Western Europe	71.60 %	72.61 %	1.4 %
Eastern Europe	67.33 %	69.76 %	3.6 %
North America	76.46 %	77.63 %	1.5 %

Source: GSMA Intelligence

Once again, the level of connectivity in Latin America is lower than in Western Europe and North America (both above 70%) and even Eastern Europe (close to 70%). Moreover, the growth rate of mobile penetration in Latin America in 2020 was lower than the world average. As in the case of fixed broadband, the mobile connectivity digital divide is also significant (around 44% of people do not have a mobile broadband connection).

Comparatively speaking, it is clear that the digital divide that separates the region from the most advanced economies is considerably smaller when it comes to mobile networks than when it comes to fixed networks. This is due to the widespread and early deployment of wireless networks in many countries in the region, in some cases even acting as a substitute technology for fixed networks for many homes or businesses. This has been helped by the fact that wireless deployments are faster and less expensive.

As expected, the prorated penetration averages hide significant differences between countries in the region. The most connected countries are Argentina, Uruguay, Chile, and Costa Rica, all of which have fixed broadband penetration of around 70% of households, and unique mobile broadband user penetration above 60%. In these countries, along with others such as Mexico, Ecuador and Colombia, the percentage of households connected to fixed broadband exceeds the percentage of the population that is a single mobile broadband user, so it can be said that there is a

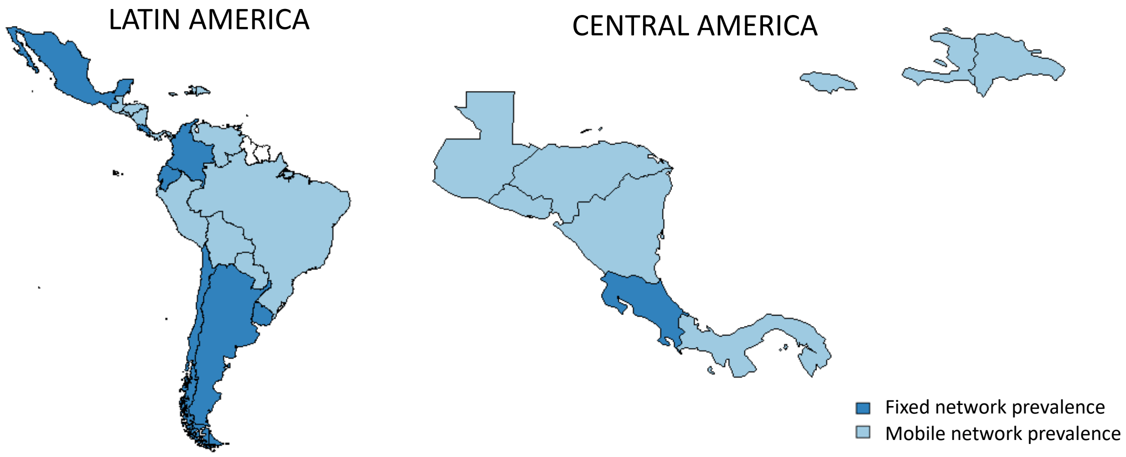
[57] Brichetti, J.P., Mastronardi, L., Rivas Amiassorho, M.E., Serebrisky, T. and Solís, B. (2021). The infrastructure gap in Latin America and the Caribbean: estimation of in - version needs until 2030 to progress towards meeting the Sustainable Development Goals. Available at: https://publications.iadb.org/publications/spanish/document/La-brecha-de-infraestructura-en-America-Latina-y-el-Caribe-estimacion-de-las-necesidades-de-inversion-hasta-2030-para-progresar-hacia-el-cumplimiento-de-los-Objetivos-de-Desarrollo-Sostenible.pdf

[58] The unique user statistic measures true penetration by excluding M2M connections and considering a user with two connections as one.

complementary relationship between fixed and mobile networks. This pattern is like that found in the world's most advanced economies.

On the other hand, in other countries (such as Central America -excluding Costa Rica-, Bolivia, Peru and Venezuela) the situation is the opposite, with mobile connectivity predominating over fixed networks. This suggests a certain trend towards substitution between the two types of networks, with wireless connectivity expanding at a faster rate (see Figure 4-1). In countries such as Guatemala and Honduras, the level of fixed broadband connectivity is less than 20% of households, while unique mobile broadband users are close to double, with this pattern of substitution being particularly pronounced.

Figure 4-1. Latin America: Adoption of Fixed and Mobile Broadband (2020)

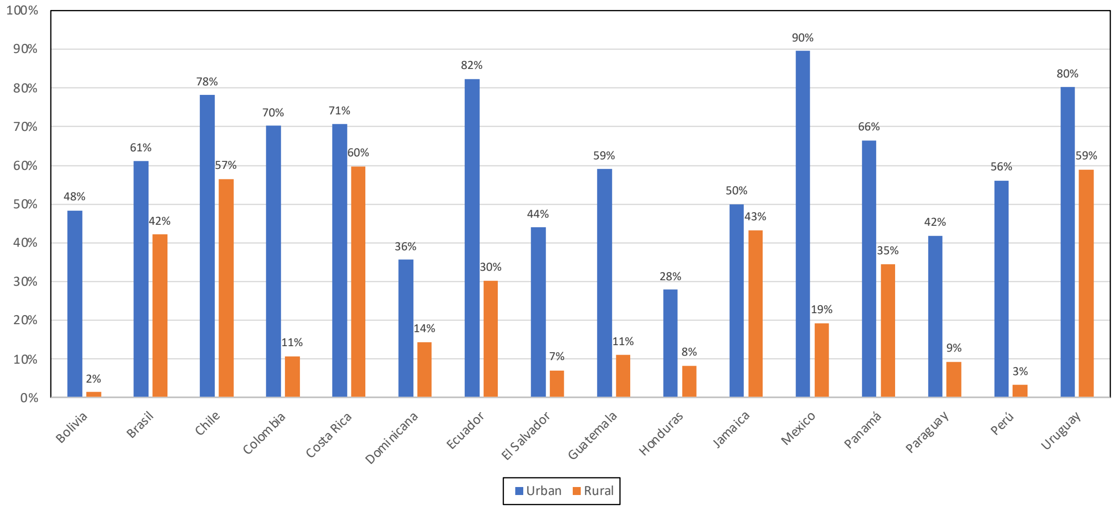


Sources: GSMA Intelligence; ITU; national regulators; operator information; Telecom Advisory Services analysis.

Notwithstanding the above, the closing of the digital divide will have to consider all solutions through a *technological mix*. For example, in the specific case of rural connectivity, it is to be expected that the closing of the digital divide will leverage wireless technologies, while in urban and suburban areas, fiber optic deployment should be a priority. It is important, therefore, to understand the main bottlenecks inhibiting the deployment of both technologies, which can be very diverse. For example, in the case of mobile connectivity, spectrum costs are a major factor, while in the case of fiber deployment in urban and suburban areas, public policy should focus on other types of incentives to reduce investment costs, such as, for example, changes in the taxation framework.

Regardless of the progress in aggregate broadband penetration per country, the digital divide exists throughout the region. It is primarily associated with the urban-rural dichotomy. Only in some small countries are there few differences in connectivity by geographic area (Costa Rica, Jamaica or Uruguay), while in Bolivia, Colombia, Ecuador, Mexico or Peru, to cite a few cases, the differences are more significant (Graph 4-2). This may be explained by population distribution and the presence of geographic features in certain countries that make service expansion more difficult and costly.

Graph 4-2. Fixed Broadband Adoption: Urban vs. Rural Context (% adopting households)



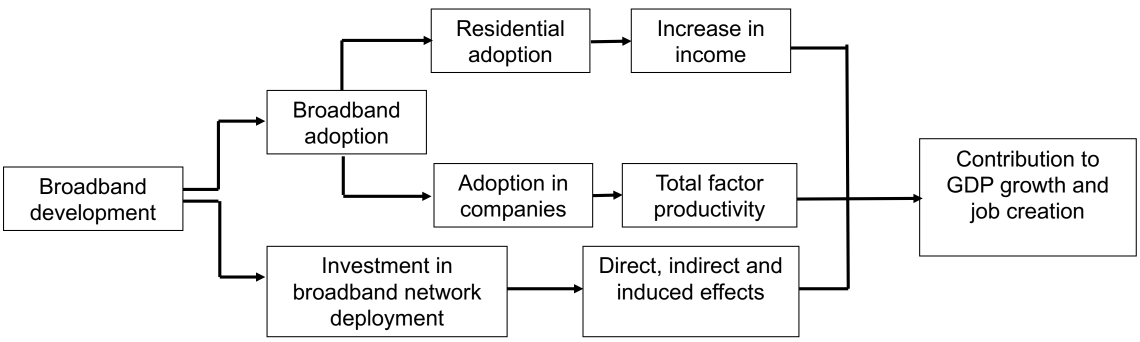
NOTE: Urban/Total and Rural/Total ratios from previous years (2018 and 2019) are applied to ITU national penetration data for 2020.
Source: ITU, Household Surveys, IDB, Telecom Advisory Services analysis.

This underlines the challenge of how to extend the level of connectivity to geographically remote locations where the digital divide is more pervasive.

4.1.2. Channels of broadband economic impact

Before estimating the economic impact of broadband networks, it is useful to understand the causal relationships, as illustrated in Figure 4-3.

Figure 4-3. Channels of broadband economic impact



Source: Katz, R. (2012). The impact of broadband on the economy. Geneva: International Telecommunications Union.

The deployment of broadband networks drives economic impact according to three channels: (i) direct, indirect, and induced effects associated with the investment for its deployment, (ii) the increase in household income and (iii) the increase in total factor productivity in companies. These three effects result in a corresponding impact on GDP. Each impact channel is examined below.

The broadband network construction process, resulting from the required investment, generates economic impact through three effects. First, construction requires capital investment for the acquisition of intermediate inputs (electronic equipment, cables, fiber optics, radio base towers), and the hiring of personnel (network technicians, construction workers, equipment production workers, etc.), which in turn drives a direct economic effect. Secondly, indirect economic effects will be generated through the acquisition of inputs from the sectors that provide inputs for the construction of networks (purchase and sale of metal, construction materials, etc.). Finally, the higher household income generated by the direct and indirect effects (i.e., of workers involved in the construction of networks and the manufacturing of inputs) will imply higher household spending, which generates the so-called induced economic effects. These three effects (direct, indirect, and induced) are grouped together in what is called the "construction effect", which takes place in the short term.

In addition, once deployed, broadband networks generate spillover effects at the consumer and enterprise levels. Spillover effects materialize at the household level, especially in terms of increased average household income. They increase due to several potential channels:

- Household members can improve their job search by accessing job boards that provide an efficient means of aligning labor demand and supply (*matching platforms*). Coincidentally, last-mile infrastructure enables household members to improve their ability to signal capabilities (resume promotion effect).
- Additionally , broadband access allows household members to access training platforms, which can increase income through better compensated work.
- In another alternative channel, broadband generates a positive effect on worker productivity. Then, following the classical labor economics literature, wages in competitive markets are equal to marginal productivity and, therefore, the higher the labor productivity, the higher wages are generated on average.
- Finally, the introduction of broadband also helps reduce job search times or allows the underemployed to seek full-time employment. This situation reduces periods of unemployment and generates an increase in the migration of underemployed workers to full-time positions, which, in turn, generates higher labor income.

The second spillover effect is at the enterprise level. According to the microeconomic analysis, the adoption of broadband reduces the cost of acquiring inputs (due to a more efficient search for suppliers), reducing the cost of operations due to better use of labor and efficiency in maintaining production chains, and better market coverage through virtual channels. These effects generate an increase in total factor productivity.

The three channels of broadband's economic impact can be estimated from its contribution to gross domestic product.

4.1.3. Estimated economic impact of broadband in Latin America and the Caribbean

The econometric estimation that allows quantifying the economic impact of broadband has been carried out according to a structural model[59] composed of four equations, which are detailed in Annex 3.

The model was estimated for both fixed broadband and mobile broadband. The table in Annex 4 presents the detailed results for the estimation of the economic impact of fixed broadband in Latin America and the Caribbean.[60] The results estimated in the main equation of the model show a positive relationship between production factors (gross capital formation and education of the labor force) and GDP per capita, as expected. On the other hand, the results of the coefficient associated with the fixed broadband variable suggest that **a 10% increase in the penetration of this type of connectivity is associated with a growth in GDP per capita of 1.47%.** This level of economic impact for Latin America is higher than the world average (0.8%), as estimated in Katz and Jung (2021)[61] .

The results of the remaining equations of the model are as expected. The demand for fixed broadband depends positively on income level and fixed telephony penetration, and as expected, negatively on price. The fact that it depends positively on fixed telephony (a service for which demand is declining today) is because fixed broadband and fixed telephony are often sold as part of a bundle. On the other hand, the higher the price, the higher the sector revenues, which are also positively affected by the level of income.

Similarly, the table in Annex 5 summarizes the results for the mobile broadband model. In this case, **a 10% increase in the penetration of unique mobile broadband users is associated with a GDP per capita growth of 1.7%**. As in the case of fixed broadband, this impact associated with mobile broadband in Latin America is higher than the world average (1.6%). The results of the remaining equations are also in line with expectations.[62]

In short, it can be concluded based on the estimates of the models in Annexes 4 and 5 that the economic impact of broadband in Latin America is very significant, being higher than the world average. Specifically, a 10% increase in the penetration of households connected to fixed broadband is associated with a per capita GDP growth of 1.47%. In the case of mobile broadband, a 10% increase in unique user adoption generates GDP per capita growth of 1.7%. Translating these estimates into economic values, considering that the prorated average GDP per capita in Latin America and the Caribbean is USD 7,202.60, a 10% increase in fixed (from 56.6% of

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[59] This type of structural models allows controlling for endogeneity that may be established between the level of GDP and broadband penetration, having been extensively used in the specialized literature (Roller and Waverman, 2001; Koutroumpis, 2009; Katz and Callorda, 2014, 2016, 2016, 2018a, 2018b, 2018c; and Katz et al, 2020a; among others).

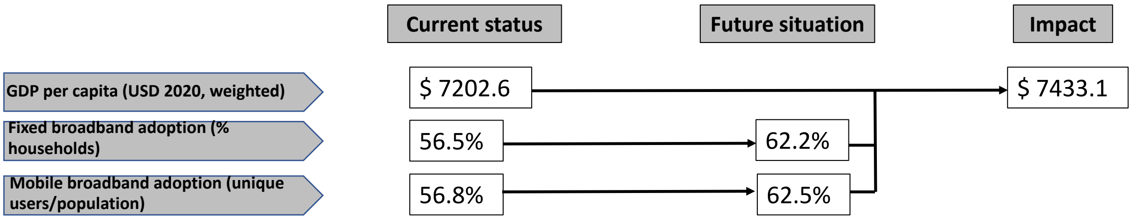
[60] The sample includes a set of Latin American countries during the period from 2010 to 2020. In total, the model has 868 observations (quarterly data) and incorporates fixed effects per country, per year and per quarter.

[61] Katz, R., Jung, J. (2021). *The Economic impact of broadband and digitization through the COVID-19 pandemic: Econometric modelling.* Geneva: International Telecommunication Union.

[62] The sample includes a set of Latin American countries during the period from 2010 to 2020. In total, the model has 639 observations (quarterly data) and incorporates fixed effects per country, per year and per quarter.

households to 62.2%) and mobile (from 56.8% of individuals to 62.5%) broadband adoption translates into a GDP per capita of USD 7,433.10 (see Figure 4-4).

Figure 4-4. Latin America: Estimated impact on GDP of a 10% increase in fixed and mobile broadband penetration



Source: Telecom Advisory Services analysis

Considering that, at an aggregate level, the region's GDP was USD 4,328.4 billion in 2020, this could increase to USD 4,467.2 billion if the proposed metrics for fixed and mobile broadband adoption are met. Consequently, for the post-pandemic recovery context, the deployment of broadband networks presents a significant potential to help the economy grow.

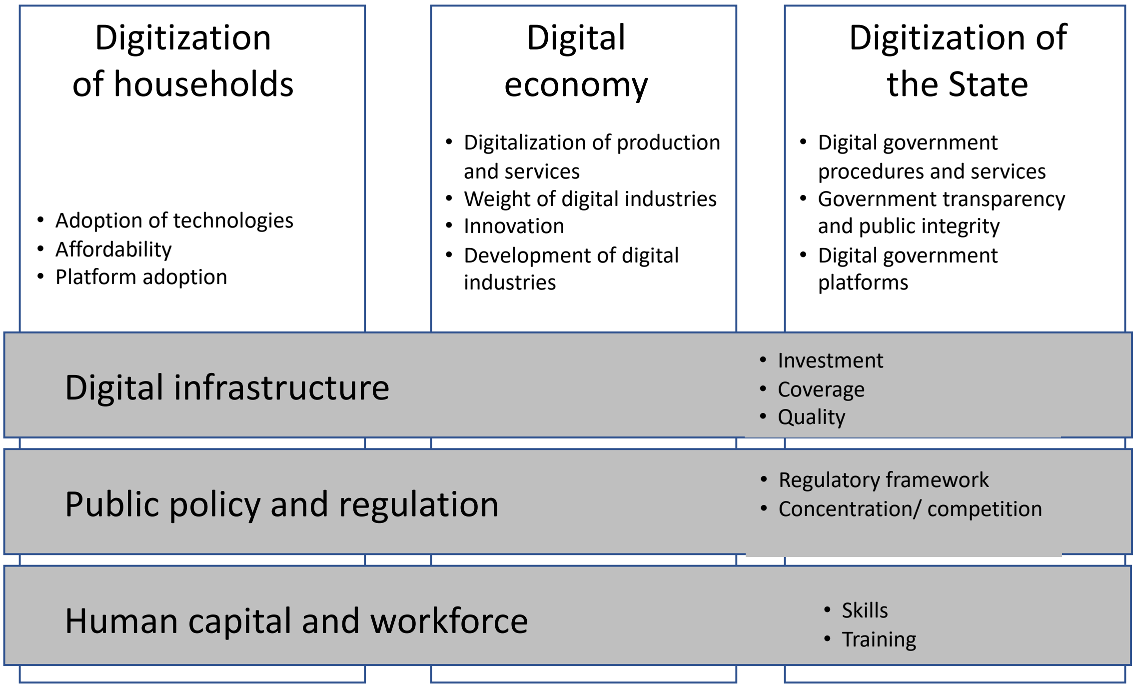
4.2. The economic contribution of digitization

The objective of this section is to estimate the impact of digitization on productivity and job creation using econometric models for Latin America and the Caribbean. To this end, we begin by presenting the current situation of digitization in the region, measured based on a digitization index. We then explain theoretically the channels of economic impact of digitization, and finally estimate its contribution based on econometric models.

4.2.1. The status of digitization in Latin America and the Caribbean

Beyond the level of broadband penetration (fixed and mobile), the concept of digitization encompasses other aspects such as the digital economy, innovation, and the use of platforms, whether from the perspective of consumers, enterprises, and the state. Cross-cutting all these dimensions are aspects related to digital infrastructure, public policy and regulation, and human capital, whose development affects a country's level of digitization. All this is summarized in the CAF Digital Ecosystem Development Index (Figure 4-5).

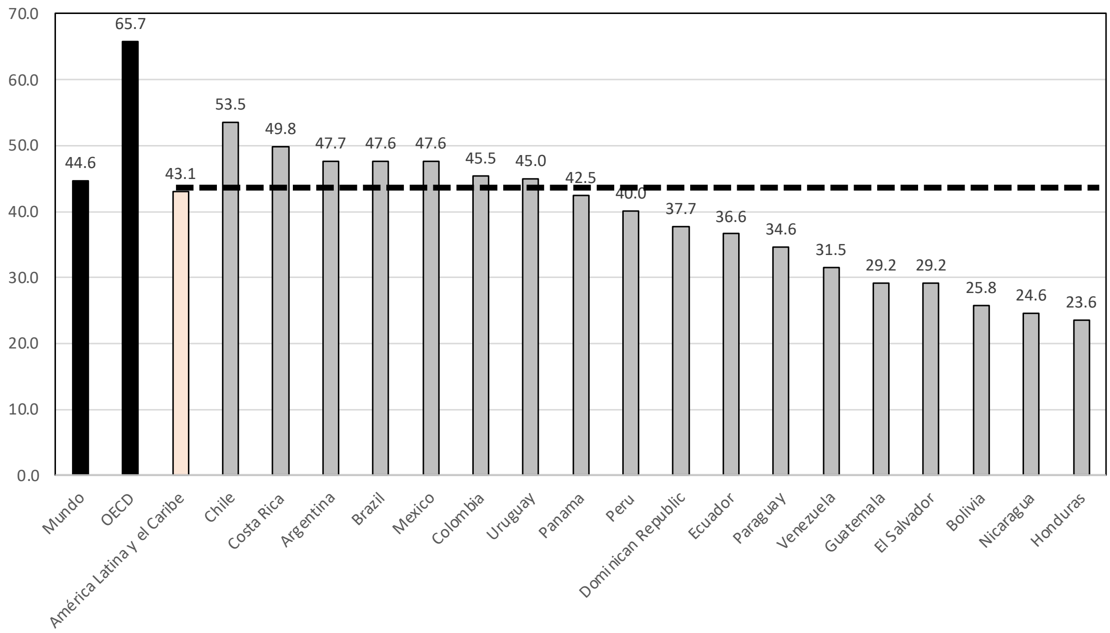
Figure 4-5. CAF Digital Ecosystem Development Index.



Source: Telecom Advisory Services (2020). CAF Digital Ecosystem Observatory (July 16, 2020).

This index has been developed from 107 indicators and calculated for 109 countries. Graph 4-3 presents the results of the CAF Digital Ecosystem Development Index for 2020.

Graph 4-3. CAF Digital Ecosystem Development Index (2020)



Source: recalculated to 2020 based on data from Telecom Advisory Services (2020). CAF Digital Ecosystem Observatory (July 16, 2020).

According to Graph 4-3, Latin America and the Caribbean register a level of digitization (43.1) close to the world average (44.6), although far from that of most advanced countries (OECD, 65.7). Beyond these differences, there is a significant disparity within the region, where Chile, Costa Rica, Argentina, Brazil, Mexico, Colombia, and Uruguay stand out with levels of digitization above the regional average. On the other hand, countries such as Honduras, Nicaragua, Bolivia, El Salvador, and Guatemala are below the regional average (all with indices below 30). It is important to note that even the regional leaders are not close to the OECD average. As mentioned above, these differences in the level of digitization reflect various factors that go beyond the level of connectivity, encompassing other aspects such as the digital economy, innovation, platform development, human capital, and digital literacy.

4.2.2. Channels of economic impact of digitization

The contribution of digitization to productivity can be conceptualized by considering the processes included in the three typical links of a company's value chain[63] :

- Procurement of inputs: this set of processes includes the purchase of raw materials and components as part of supply chain management processes. The degree of digitization in the procurement of inputs studies the assimilation of platforms and information transmission and processing systems to reduce transaction costs incurred in purchasing, inventory management, and logistics.

- Processing or operations: internal processes used to transform inputs into products to be sold in the market. In this case, the level of automation of internal processes is studied, as well as the interaction with firms that provide outsourced services and/or components to the raw material transformation process. In this case, digitization includes the assimilation of *business-to-business* platforms, as well as the adoption of internal production planning systems, such as *Enterprise Resource Planning*.

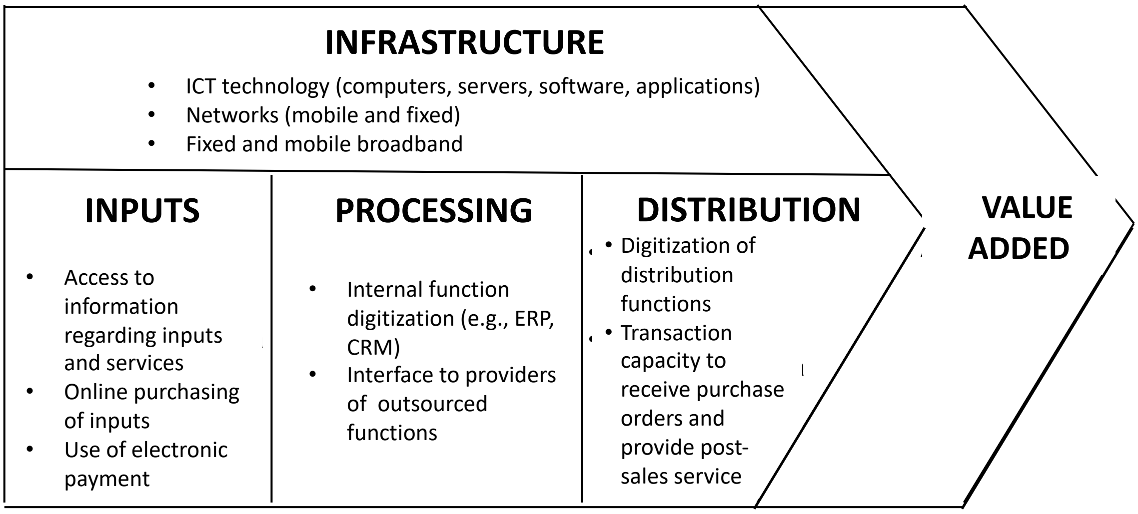
- Distribution: sale and delivery (including logistics) of products to the market. Digitization has a positive impact in this case resulting from the adoption of new price signaling platforms (digital advertising), distribution costs, and logistics (transportation, warehousing, etc.). On the one hand, the price of the product to be offered in the market can be increased because of better signaling to the potential market. On the other hand, distribution costs can be reduced by optimizing sales channels.

To these three vertical processes of the value chain, a horizontal process must be added that includes the acquisition of technology by the company. Based on the essential components of computing, high-speed fixed broadband and mobile voice and data communications, the digitization of infrastructure includes cloud computing services, applications for customer behavior analysis, the deployment of sensors in production processes (such as the Internet of Things), and operations monitoring.

[63] The concept is based on the one developed by Porter, M. (1985). *Competitive Advantage*. New York: The Free Press.

The combination of the four value chain processes reduces production costs and increases consumer willingness to pay, thereby increasing productivity (see Figure 4-6).

Figure 4-6: Impact of digitization on the Value Chain



Source: Katz et al. (2017). Annual report of the digital economy in Colombia. ICT Ministry and Chamber of Commerce of Bogota.

Efficiencies in production units can be achieved in two ways. First, each function in the value chain can raise its level of performance simply by automating tasks and reducing transaction costs related to the acquisition of products and services necessary to carry out that task. For example, in the transportation sector, artificial intelligence solutions can optimize inventory management, increase visibility into transportation operations, and facilitate vehicle routing, among others. Secondly, digitization can optimize interactions between actors involved in the value chain for the provision of infrastructure services. For example, the implementation of sensors in materials can increase their traceability and quality along the supply chain. Thus, digitization often leads to improvements in business productivity by facilitating the adoption of more efficient processes (e.g., marketing, inventory optimization, supply chains), the introduction of new services, and the efficient operation of businesses by improving the possibilities of accessing human capital, raw materials, intermediate inputs, and reaching customers, even in foreign markets, which encourages exports.

As in the case of the impact on productivity, digitization can also affect the level of employment. As a counterbalance to the disappearance of jobs because of automation, digitization creates employment. As stated by Aghion and Howitt (1994), technological progress generates a "capitalization" effect, which makes it possible to offset (even partially) job losses due to automation.[64] This is explained by the fact that digitization generates a positive economic effect (due to increased returns to capital), which can contribute to reducing unemployment. On the other

[64] Aghion, Philippe and Howitt, Peter (1994). "Growth and unemployment", *The Review of Economic Studies*, Volume 61, Issue 3, 1 July, pp. 477-494.

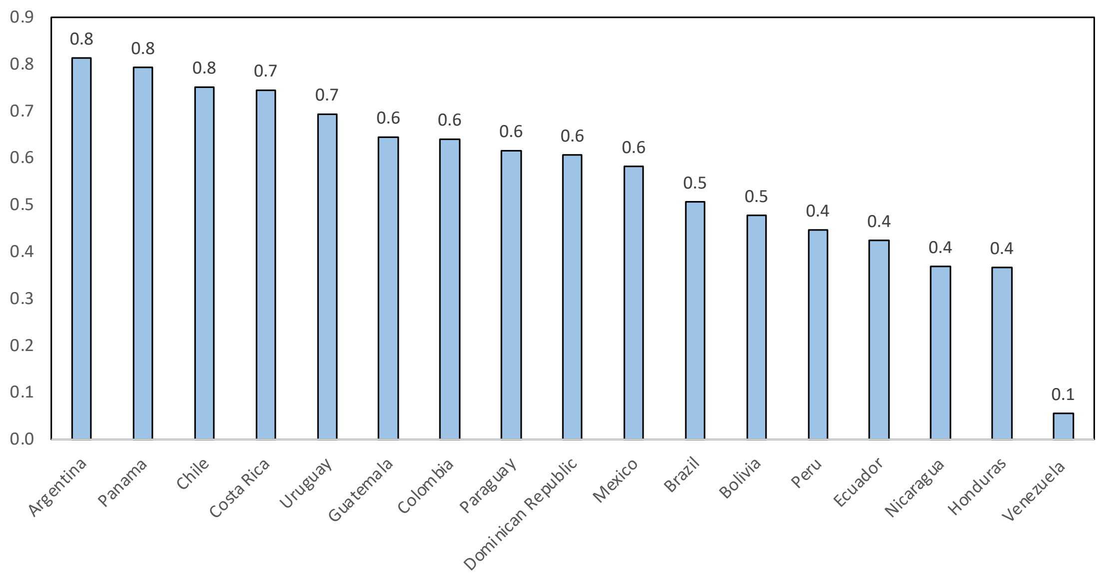
hand, authors such as Spitz-Omer[65] , Autor and Dorn[66] , and Acemoglu and Restrepo[67] state that workers will redefine their tasks, orienting them more towards complementarity with technology. This will result in many jobs being restructured, but not disappearing. In a study analyzing job creation in Chile due to digitization, Katz et al. (2021) create enough jobs to compensate for the automation-induced disappearance of jobs.[68]

4.2.3. Estimated economic impact of digitization in Latin America and the Caribbean

Impact of digitization on total factor productivity

As illustrated in Graph 4-4, digitization positively impacts total factor productivity. As a starting point to verify this effect, the productivity data reported by the *Penn World Tables* for 2019 illustrate important differences among countries in the region in terms of their relationship with U.S. productivity. Graph 4-4 presents the level of productivity for each country relative to that of the United States (with the U.S. =1).

Graph 4-4. Latin America: Total Factor Productivity Relative to the U.S. in PPP (2019, U.S. =1)



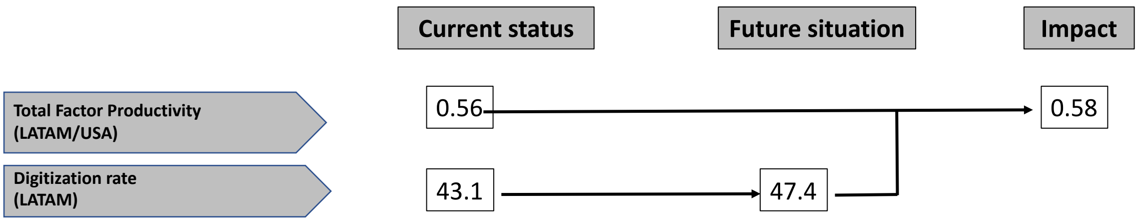
Source: Penn World Tables

[65] Spitz-Omer (2016). "Technical Change, Job Tasks, and Rising Educational Demands: Looking outside the Wage Structure," *Journal of Labor Economics*, Vol. 24, pp. 235-270.
[66] Autor, D. and Dorn, D. (2013). "The Growth of Low-Skill Service Jobs and the Polarization of the US Labor Market," *American Economic Review*, Vol. 103, No. 5, August, pp. 1553-97.
[67] Acemoglu, D. and Restrepo, P. (2015), *The Race Between Man and Machine: Implications of Technology for Growth, Factor Shares and Employment*, unpublished, December 2015.
[68] Katz, R, Callorda, F; Jung, J. (2021). "The impact of automation on employment and its social implications: evidence from Chile". *Economics of Innovation and New Technology*. DOI: 10.1080/10438599.2021.1991798

Countries such as Argentina, Panama or Chile have high productivity levels, around 80% of the US (after adjustments for purchasing power parity). That is, for a similar quantity of inputs, these countries manage to extract 80% of the production that the United States would achieve with the same inputs. However, there are several countries that lag far behind, since their productivity level does not reach 50% of the U.S. benchmark. This is the case of Peru, Ecuador, Nicaragua, Honduras, and Venezuela. In other words, with a similar amount of inputs, these countries do not achieve 50% of the production that the United States would achieve with them. Digitization is an opportunity for countries lagging in productivity to make progress in this area. In general, when comparing Graphs 4-3 and 4-4, the most digitized countries are also the most productive. To quantify this relationship, we apply a regression that links total factor productivity as the dependent variable, and capital stock per worker, human capital, and the level of digitization as explanatory variables (the equation to be estimated is presented in Annex 6).

The regression results, for the sample of Latin American countries, are presented in the table in Annex 7. They suggest that **a 10% increase in the digitization index is associated with an increase in total factor productivity of 5.7% in Latin America**, the result being statistically significant. Again, translating these estimates into concrete values, considering that the prorated average productivity level ratio of Latin America and the Caribbean with respect to the United States is 0.56, a 10% increase in the prorated digitization index (from 43.1 to 47.4) translates into an increase in the productivity ratio to 0.58 (see Figure 4-7).

Figure 4-7. Latin America vs. Estimated impact on the productivity ratio of a 10% increase in the digitization index.



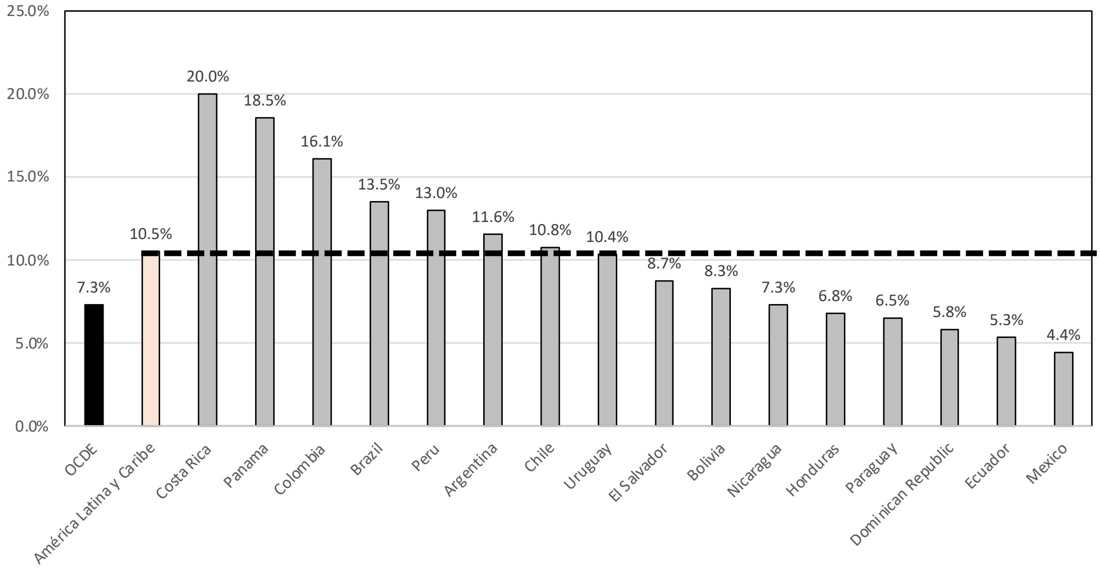
Source: Telecom Advisory Services analysis

It is important to remember that the Digitization Index measures much more than connectivity indicators, encompassing other aspects such as the digital economy, innovation, platform development, human capital, and digital literacy. Therefore, to achieve progress in terms of measuring digitization in a broad sense requires, in combination with the deployment of networks, public policies acting on several fronts simultaneously.

Impact of digitization on employment

As detailed theoretically in the previous section, digitization also contributes to job creation. In this context, it is important to note that the pandemic has had an impact on current unemployment levels, especially affecting countries such as Costa Rica, Panama, and Colombia, all with rates above 15% in 2020 (Graph 4-5). Likewise, there is an important disparity in the region, given that, despite the pandemic, countries such as Mexico, Ecuador or the Dominican Republic have been able to maintain unemployment levels below 6%[69] .

Graph 4-5. Unemployment Rate, 2020 (%)

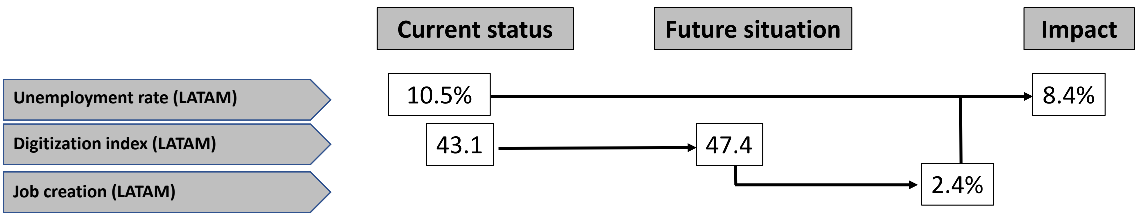


Sources: IMF, World Bank

To estimate the impact of digitization on employment, a regression was developed based on the equation presented in Annex 8. The equation assumes that the level of employment depends on the capital stock of the economy, the level of training of workers (Human Capital) and the level of digitization. The econometric estimation of the model for the countries of the region allows us to identify that employment levels depend positively on digitization. Specifically, **a 10% increase in the digitization index for Latin America and the Caribbean increases employment by 2.4%** (see table in Annex 9).

Considering that the average unemployment rate in Latin America stood at 10.5% in 2020, a 10% increase in the digitization rate would reduce it to 8.4% according to the coefficient presented in Annex 9 (see Figure 4-8), which results in the creation of more than 6.5 million new jobs.

Figure 4-8. Latin America: Estimated impact on job creation of a 10% increase in the digitization rate.



Source: Telecom Advisory Services analysis

[69] Although the data have been standardized for comparative purposes by the IMF, it cannot be ruled out that differences in definitions and measurement methodologies may explain part of the disparities between countries.

In conclusion, the jobs created from the development of digitization would outweigh the jobs lost because of task automation, the net effect being positive. This suggests the relevance of the "capitalization" effect suggested by Aghion and Howitt (1994) (cited above), and of the job restructuring process. In turn, as demand for jobs increases, wages would tend to rise due to the increase in labor formality. [70]

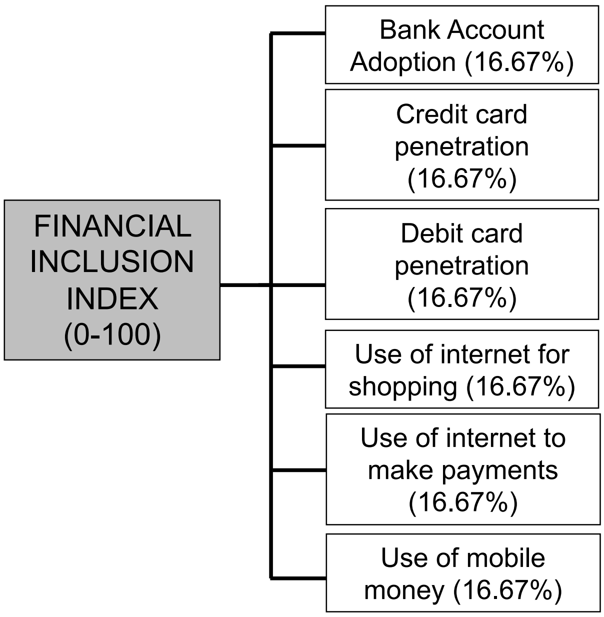
4.3. The impact of mobile broadband on financial inclusion

4.3.1. The current state of financial inclusion in Latin America and the Caribbean

Financial inclusion considers the population's access to useful and affordable financial services that allow them to make transactions, payments, savings, obtain credit and insurance under reasonable conditions. Access to financial services facilitates daily life and helps families and businesses to plan ahead. Once they have access to a bank account, people are more likely to start using other financial services, such as credit and insurance.[71] Financial inclusion is seen as a key element in reducing poverty and boosting prosperity and has become a priority for governments and international agencies in recent years.

To analyze the levels of financial inclusion, an index was constructed to measure it, based on the data reported by the World Bank's Global Findex (see Figure 4-9).

Figure 4-9. Financial Inclusion Index



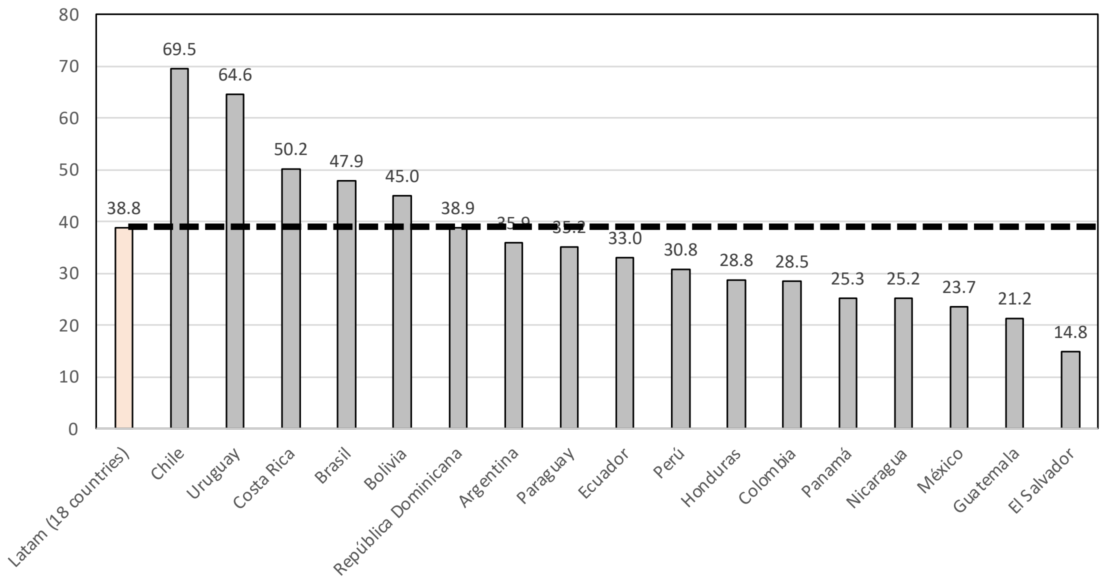
Source: Telecom Advisory Services analysis

[70] See Katz, R et al. (2022). *Quantitative Study to Estimate the Socioeconomic Impact of Last Mile Connectivity Deployment in Latin America.* Inter-American Development Bank Technical Paper (in process of publication).
[71] See World Bank (2018). Financial Inclusion. Downloaded from: https://www.bancomundial.org/es/topic/financialinclusion/overview#1

Given that the Global Findex base does not have continuous periodicity but covers only the years 2011, 2014 and 2017, to perform a causal analysis, data have been extrapolated to missing years assuming a constant compound annual growth rate in each time interval. This index is composed of six equally prorated indicators, as detailed in Figure 4-9. It implies assuming a concept of financial inclusion that goes beyond the simple adoption of a bank account but considers other aspects such as the penetration of cards (credit and debit), and the use of the internet to make purchases or payments.

The financial inclusion index made it possible to calculate the position of each country in the region (see Graph 4-6).

Graph 4-6. Financial Inclusion Index, 2020



Sources: Findex; Telecom Advisory Services analysis

Chile and Uruguay are by far the countries in the region with the best levels of financial inclusion (reaching 69.5 and 64.6 points respectively out of a possible total of 100). Costa Rica, Brazil and Bolivia, despite being considerably behind the two leaders, remain above the regional average (38.8). Once again, there is a significant disparity in the region, with countries such as Mexico, Guatemala and El Salvador standing out with low scores. This implies that there is still a long way to go in the region in terms of financial inclusion, and digital technologies could be an opportunity to make progress in this regard.

4.3.2. Estimating the Impact of Mobile Broadband on Financial Inclusion in Latin America and the Caribbean

As explained by Andrianaivo and Kpodar[72] , by reducing transaction costs and helping to counteract the difficulties of physically accessing banks from remote locations, mobile broadband connectivity helps the expansion and access of financial services, especially by the most vulnerable sectors of the population.

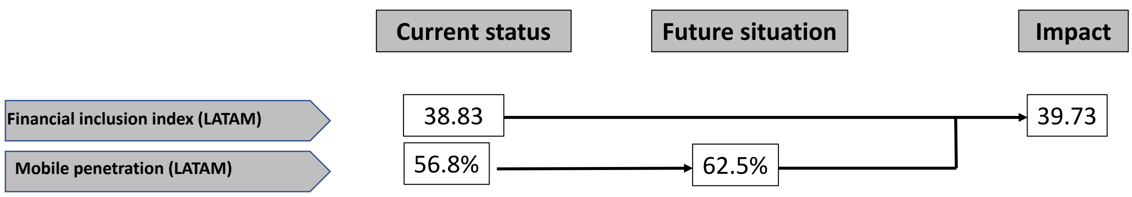
[72] Andrianaivo, M. and Kpodar, K. (2011). *Financial inclusion and growth: Evidence from African countries*. International Monetary Fund Working Paper WP/11/73.

Digitization in turn improves the development of information flows, crucial for credit analysis.

Based on this conceptual consideration, a regression model is used to estimate the impact of mobile broadband on the level of financial inclusion. To this end, it is assumed that financial inclusion depends on the level of human capital (the higher the education, the greater the probability of using electronic money), the level of income (GDP per capita), the level of rural population (the larger the rural population, the lower the level of financial inclusion, due to lower worker education and a lower level of formalization of the economy), and the level of Internet connectivity (approximated through the level of mobile broadband penetration) (detailed equation in Annex 10). The results of the model estimation for Latin American and Caribbean countries are presented in the table in Annex 11.

According to the mobile broadband impact coefficient (0.232), there is a positive and significant contribution of this technology to the level of financial inclusion. Applying the coefficient estimated in Annex 11 to the current level of financial inclusion in Latin America, it is possible to calculate that it would increase from 38.8 to 39.7 if mobile broadband penetration were to increase by 10% (see Figure 4-10). Although this increase may seem modest, it is important to bear in mind that all financial instruments are currently in the process of digitization, so it can be expected that this impact will tend to grow in the short term, with the additional impact of digital literacy programs.

Figure 4-10. Latin America: Estimated impact on financial inclusion of a 10% increase in mobile broadband penetration.



Source: Telecom Advisory Services analysis

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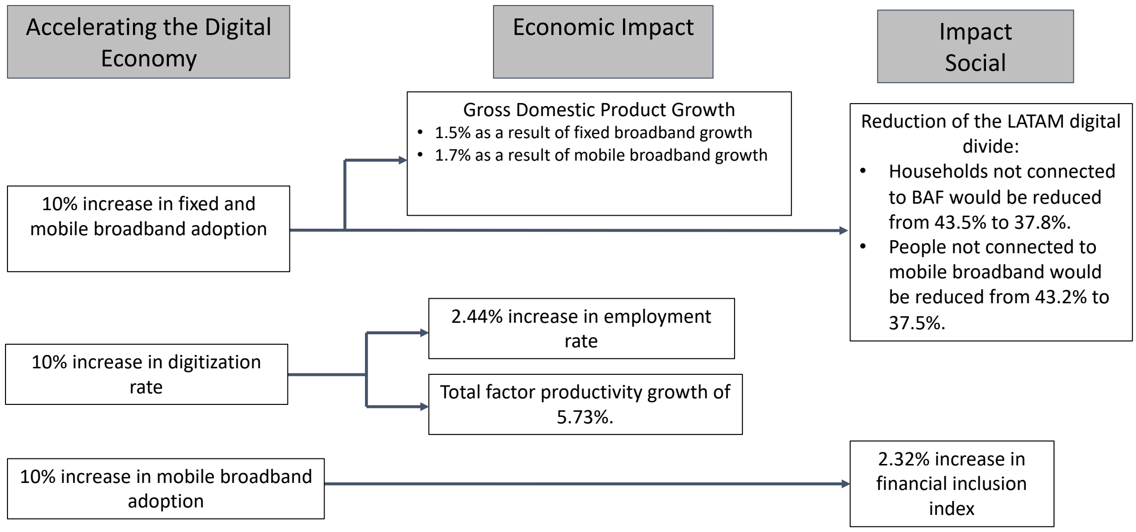
In summary, the economic and social impact of the development of digitization can be summarized as shown in Figure 4-11.

Figure 4-11. Economic and social impact of digitization



Source: Telecom Advisory Services analysis

The impacts stipulated in Figure 4-11 reflect the importance of broadband deployment and the development of the digital economy for the economic recovery of the region. In short, it can be summarized that a 10% increase in fixed broadband penetration generates a per capita GDP growth of around 1.5% (economic impact), which in turn generates an important social effect, given that the digital divide would be substantially reduced (unconnected households would be reduced from 43.5% to 37.8%). Similarly, a 10% increase in mobile broadband penetration generates a per capita GDP growth of 1.7%, reducing the digital divide since the percentage of unconnected people would be reduced from 43.2% to 37.5%. An increase in mobile broadband penetration also generates an important social effect by promoting financial inclusion. On the other hand, a 10% increase in the digitization index is associated with a 2.4% increase in the level of employment and a 5.7% increase in total factor productivity. Naturally, the increase in GDP, productivity and employment will generate reductions in poverty in the region, which magnifies the potential social effect of connectivity.

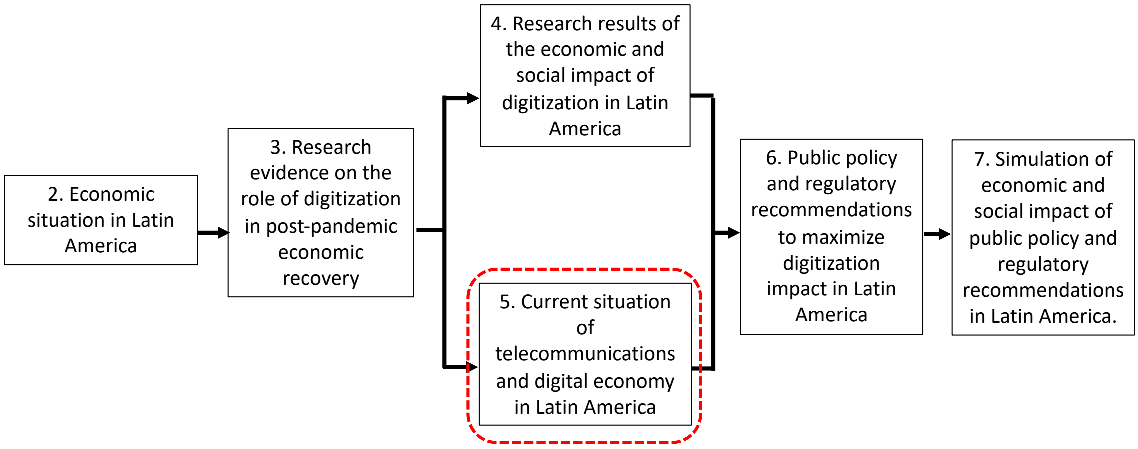
However, for these effects to occur, it is necessary to generate the necessary conditions and incentives in the telecommunications and digital ecosystems. They can be grouped into three categories: changes in the regulatory framework of the telecommunications sector, new public policies for development of the digital economy, and changes in the taxation framework for telecommunications operators, as well as in the cost of spectrum.

5. CURRENT SITUATION OF TELECOMMUNICATIONS AND THE DIGITAL ECONOMY IN LATIN AMERICA AND THE CARIBBEAN

The socioeconomic impact analyses presented in Chapter 4 indicate that the acceleration of the development of the telecommunications industry and the digital economy, as a key factor in economic recovery, should be leveraged by an increase in fixed and mobile broadband penetration, an increase in digitization, and a growth of the local digital economy. The growth in broadband penetration is, in turn, determined by an increase in coverage and affordability. On the other hand, the increase in the rate of digitization is conditioned not only by the deployment of telecommunications infrastructure, but also by the growing assimilation of digital technologies in enterprises, the electronic provision of public services, and an acceleration in the pace of innovation. Finally, the growth of the digital economy, which includes audiovisual production, is, in turn, determined by an increase in local investment and the development of human capital.

The following chapter presents the current situation in the region in terms of three critical enablers of the digital economy: investment in telecommunications networks, affordability of digital technologies, and human capital accumulation (see Figure 5-1).

Figure 5-1. General framework of the study



This analysis presents the starting point of key enabling factors to be developed based on implementation of public policies, coupled with changes in the regulatory and fiscal frameworks.

5.1. Capital investment in the telecommunications sector

Latin America and the Caribbean invests a prorated USD 33.82 per capita in telecommunications, which is below the world average and significantly lower than advanced economies (see Table 5-1).

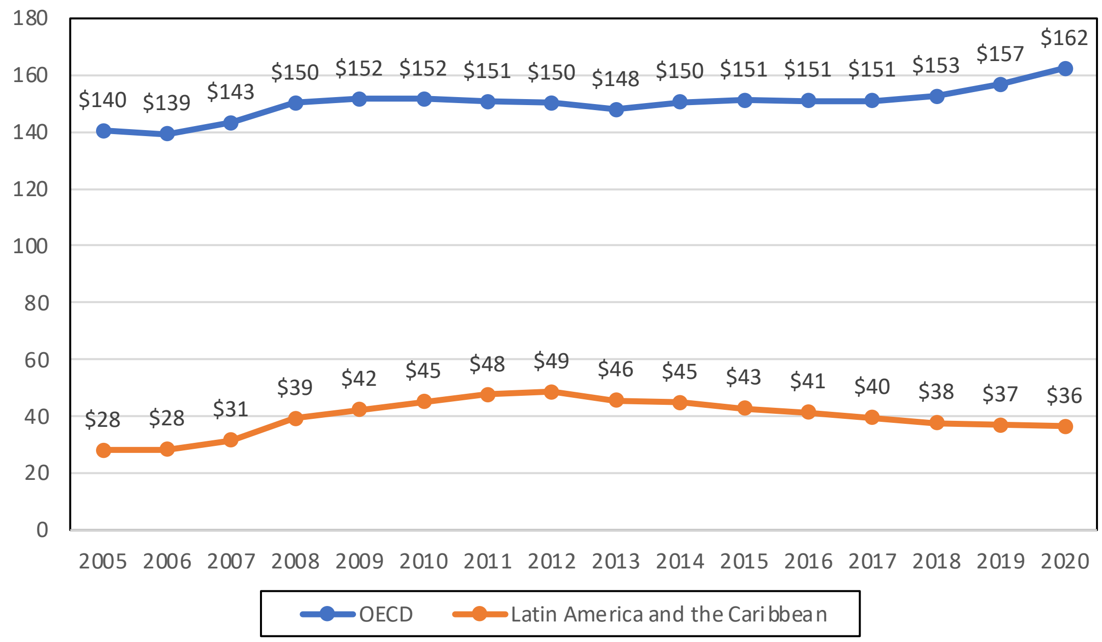
Table 5-1. Investment in telecommunications per capita (in US$)

Region	2019	2020	Delta
World	$ 51.43	$ 51.81	0.7%
Sub-Saharan Africa	$ 8.50	$ 7.56	-11.0%
Latin America and the Caribbean	$ 36.40	$ 33.82	-7.1%
North America	$ 344.99	$ 337.09	-2.3%
Asia and Pacific	$ 26.31	$ 28.11	6.8%
Western Europe	$ 121.60	$ 121.38	-0.2%
Eastern Europe	$ 38.76	$ 40.36	4.1%
Arab States	$ 39.66	$ 43.37	9.4%

Sources: ITU, GSMA Intelligence, Telecom Advisory Services analysis.

There are certain environmental conditions that make it natural for investment levels in advanced economies to be higher. These are countries with higher per capita income, where carriers have a greater capacity to finance and make investments profitable. That being said, a matter of concern remains that, beyond the structural differences, the investment gap between Latin America and the Caribbean and OECD nations is widening rather than narrowing (see Graph 5-1).

Graph 5-1. Investment in telecommunications per capita (average 5 years)



NOTE: the annual investment has been averaged over five years to reduce the volatility that characterizes the annual CAPEX.

Sources: ITU and GSMA Intelligence, Telecom Advisory Services analysis.

Considering the need to fund the deployment of advanced technologies such as 5G and fiber optics, Latin America's lag with respect to the OECD in terms of capital investment is a worrying factor. Table 5-2 presents a comparison of fiber optic and 5G coverage between Latin American and Caribbean countries and the rest of the world.

Table 5-2. Coverage of next-generation networks (2020)

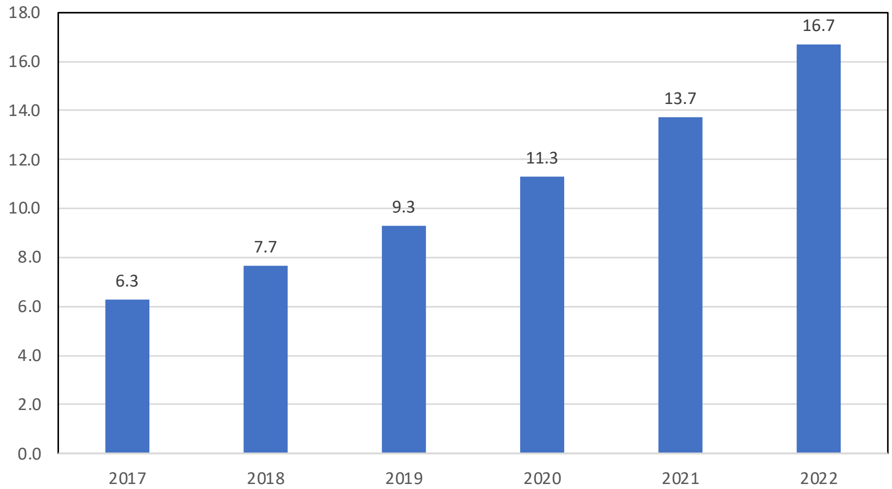
Region	5G	FTTx
World Cup	15.96 %	42.6 %
Africa	0.00 %	1.1 %
Latin America and the Caribbean	3.34 %	40.4 %
Asia Pacific	14.92 %	44.6 %
Arab States	15.33 %	7.2 %
Commonwealth of Independent States	16.61 %	60.1 %
Europa	24.12 %	60.1 %
North America (includes DOCSIS 3.0)	63.75 %	73.3 %

Sources: IDATE; Broadband now; GSMA Intelligence, Telecom Advisory Services analysis.

Regardless of future projections, the situation in 2020 in terms of the comparative deployment of next-generation technologies confirms that the lag in investment translates into a gap in the deployment.

Compounding this gap, it is important to note that traffic over Internet networks (both in the region and in the rest of the world) is growing considerably and will continue to do so in the coming years.[73] This trend will require carriers to increase their investments to accommodate this growth (Graph 5-2).

Graph 5-2. Monthly Internet Traffic in Latin America (in Exabytes)

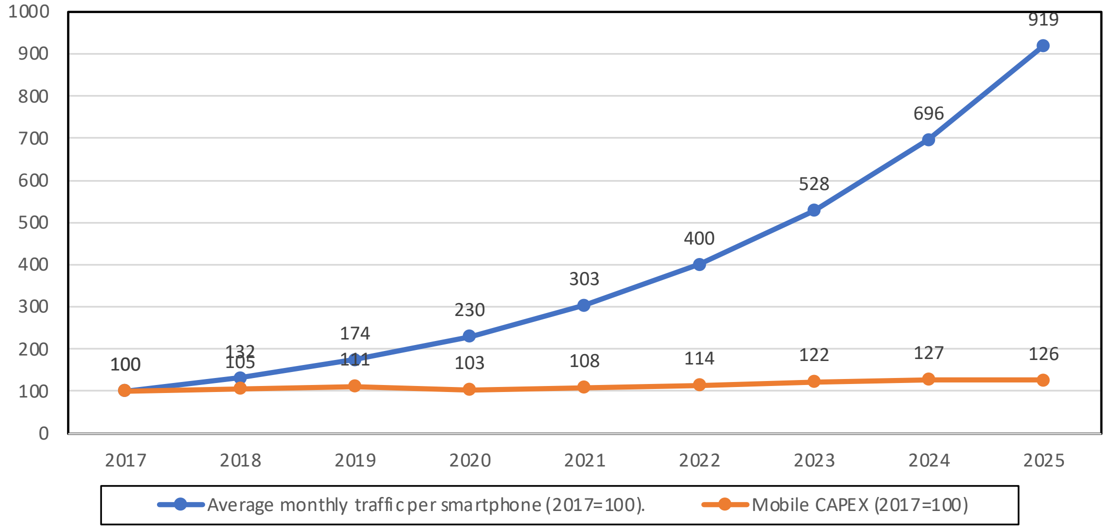


Source: CISCO

Contrary to what is required by the increase in traffic, regional levels of capital investment are not trending in the same direction. This is the case in mobile networks. Graph 5-3 illustrates the recent evolution and forecast of indexed mobile CAPEX (according to GSMA Intelligence) and traffic per smartphone (according to CISCO).[74]

[73] CISCO reports data for Latin America for the years 2017 and 2022. The intermediate years of that series were interpolated assuming a constant TACC in that period.
[74] CISCO's latest projection for Latin America goes up to 2022. From there, we project the evolution until 2025 assuming a constant CAGR.

Graph 5-3. Average monthly traffic per smartphone and mobile CAPEX (2017=100).



Source: CISCO and GSMA Intelligence

One should recognize that the transmission capacity per dollar invested tends to increase with technological advances. However, technological progress is not enough. It is reasonable to assume that, if traffic continues to grow as expected, and the necessary investments and spectrum availability do not materialize to increase network capacity, a bottleneck will result, with the consequent deterioration of the quality of service. This makes it urgent to find mechanisms to accelerate and encourage telecommunications CAPEX.

Finally, accelerating investment is a *sine qua non* factor for addressing the digital divide. As detailed in Chapter 3, network coverage in rural areas is still lagging. If the digital divide is addressed, there will be an increasing number of people connected from newly served areas. This additional traffic may not be reflected in traffic growth estimates, which reinforces the urgency of increasing investment in network deployment. Decisive action in the public policy and regulatory domain is needed to create favorable conditions to stimulate such deployments.

5.2. Affordability of telecommunications services

Growth in mobile broadband adoption has been fueled by an increase in affordability. Between 2019 and 2020, mobile broadband affordability has grown by 10%. On the other hand, fixed broadband prices have not followed the same trend, although the quality of service has improved considerably, with network speeds increasing by 50% between 2019 and 2020[75] (see Table 5-3).

[75] The average fixed broadband speed in the region has increased from 38.8 in 2019 to 58.2 in 2020 (Source: Ookla/Speedtest).

Table 5-3: Increase in affordability (Service price as a percentage of GNI per capita)

Region	Fixed broadband			Mobile Broadband		
	2019		Delta	2019		Delta
World Cup	7.39 %	7.14 %	-3.3 %	1.60 %	1.51 %	-5.1 %
Africa	51.61 %	46.08 %	-10.7 %	7.03 %	5.68 %	-19.2 %
Latin America and the Caribbean	3.18 %	3.62 %	13.9 %	1.97 %	1.78 %	-10.0 %
Asia Pacific	2.83 %	3.12 %	10.3 %	0.95 %	1.08 %	-13.0 %
Arab States	3.20 %	3.55 %	10.9 %	1.27 %	1.05 %	-17.0 %
Commonwealth of Independent States	0.88 %	0.77 %	-12.5 %	0.99 %	0.86%	-12.6 %
Europa	1.32 %	1.27 %	-3.7 %	0.60 %	0.61 %	1.6 %
North America	0.86 %	1.00 %	16.3 %	0.44 %	0.43 %	-4.5 %

Source: Katz, R. and Jung, J. The economic impact of broadband and digitization through the COVID-19 pandemic: Econometric Modelling. Geneva: International Telecommunication Union.

The affordability barrier to broadband adoption in the region exists at the base of the socio-demographic pyramid. If the economic barrier to adoption is to be resolved, it is important to introduce affordable offers targeted to the most vulnerable population. This requires public policies that stimulate the launch of affordable offers, coupled with the introduction of targeted measures, such as subsidies, for the most disadvantaged segments.

Considering the latest available data for 15 countries in Latin America and the Caribbean, it can be observed that the average income in the first decile is only 17% of the overall average income, in the second decile 31% and in the third decile 41% (see Table 5-4).

Table 5-4. Income per decile as a percentage of median income for Latin American and Caribbean countries (latest available year)

Country	Year	Decile 1	Decile 2	Decile 3
Argentina	2019	17%	31%	42%
Bolivia	2019	17%	34%	46%
Brazil	2018	10%	22%	31%
Chile	2017	23%	35%	44%
Colombia	2019	12%		34%
Costa Rica		12%		35%
Dominican Republic	2019		38%	47%
Ecuador	2019	16%	29%	
El Salvador	2019	24%	39%	49%
Honduras	2019	12%	23%	35%
Mexico	2018	20%	33%	43%
Panama	2019	12%	24%	35%
Paraguay			31%	42%
Peru	2019	18%	33%	45%
Uruguay	2019	23%	36%	47%
Latin America and the Caribbean (*)		17%	31%	41%

(*) Simple average of the 15 countries for which data are available.
Sources: SEDLAC (CEDLAS and World Bank) based on microdata from Household Surveys, analysis by Telecom Advisory Services.

When considering the population of the third income decile in Latin America and the Caribbean, the price of fixed broadband by 2020 implies 8.84% of GNI per capita instead of the 3.62% for the average population (see table 5-5).

Table 5-5. Price of broadband service as a percentage of GNI per capita by decile for Latin America and the Caribbean (2020)

Country	Average	Decile 1	Decile 2	Decile 3
Fixed Broadband	3.62%	20.83%	11.86%	8.84%
Mobile Broadband	1.78%	10.24%	5.83%	4.35%

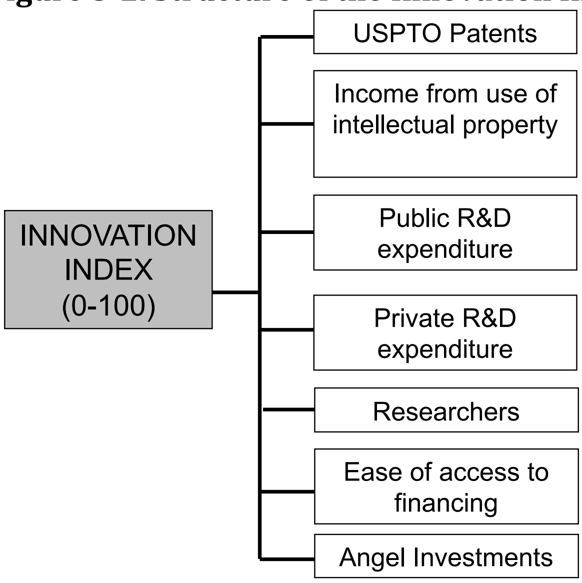
Sources: SEDLAC (CEDLAS and World Bank) based on microdata from Household Surveys, Katz, R. and Jung, J. (2021) The economic impact of broadband and digitization through the COVID-19 pandemic: Econometric Modelling. Geneva: International Telecommunication Union; analysis by Telecom Advisory Services.

This situation becomes even more critical for the population in the first income decile, where the price of fixed broadband service represents an expenditure of 20.83% of their GNI per capita.

5.3. Pace of innovation in the digital economy

The innovation dynamic of a country or region, a central component in the development of the digital economy, was quantified based on an index that combines statistics on associated financial and human resources (see Figure 5-2).

Figure 5-2. Structure of the Innovation Index[76]

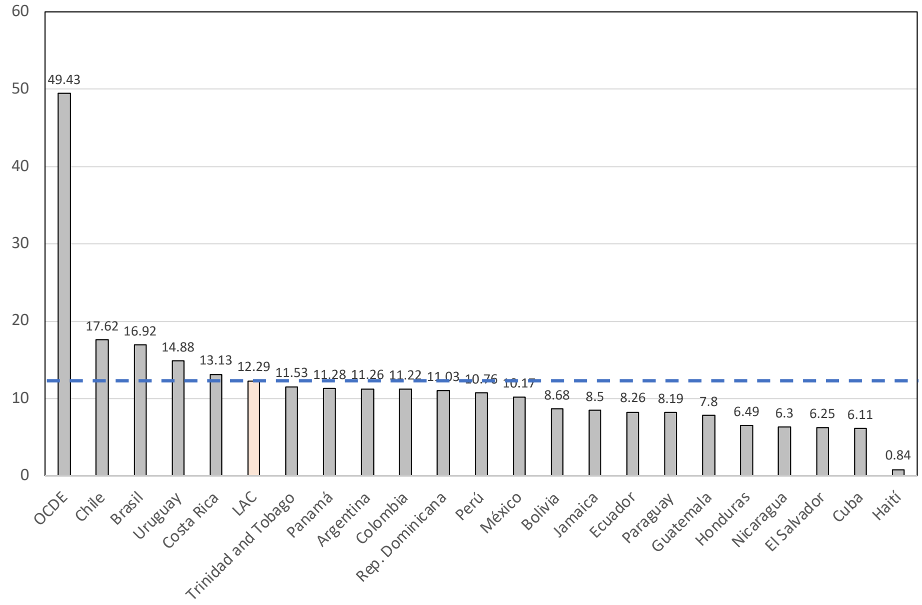


Sources: World Bank; UNESCO; CB Insight; OECD; Telecom Advisory Services analysis.

This index allows a comparison of the innovation dynamics of Latin America and the Caribbean relative to other regions, as well as the performance of countries in the region. In aggregate, the region lags significantly behind the average of the advanced economies. Furthermore, the level of innovativeness by Latin American country indicates that, although none of them reaches the OECD average, some have a significantly higher innovation index than others: Chile, Brazil, Uruguay, and Costa Rica (see Graph 5-4).

[76] Each indicator is prorated by different weights.

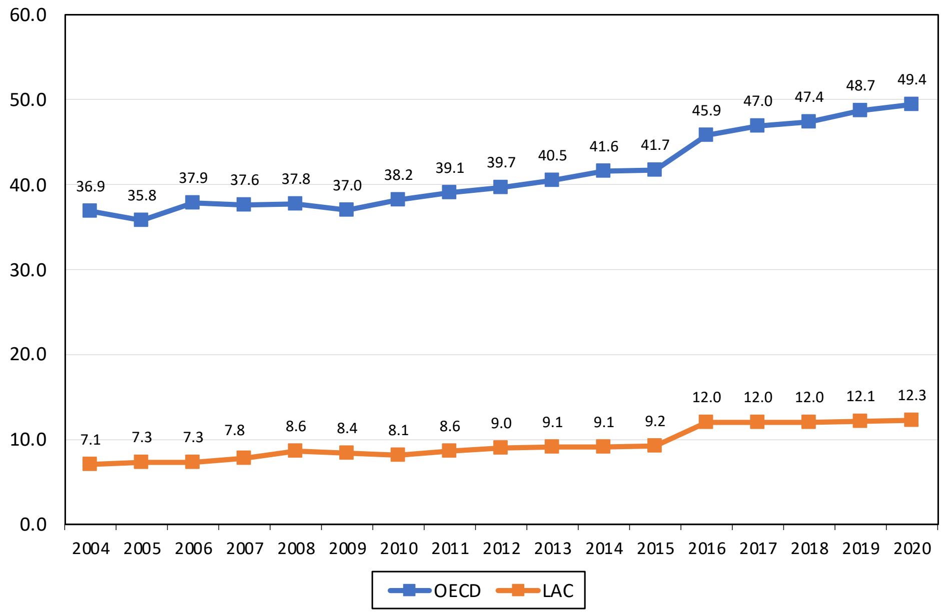
Graph 5-4. Latin America and the Caribbean: Innovation Index (2020)



Source: Telecom Advisory Services analysis

On the other hand, contrary to what it is required, the innovation gap that separates Latin America and the Caribbean from the average of the OECD countries is widening (see Graph 5-5).

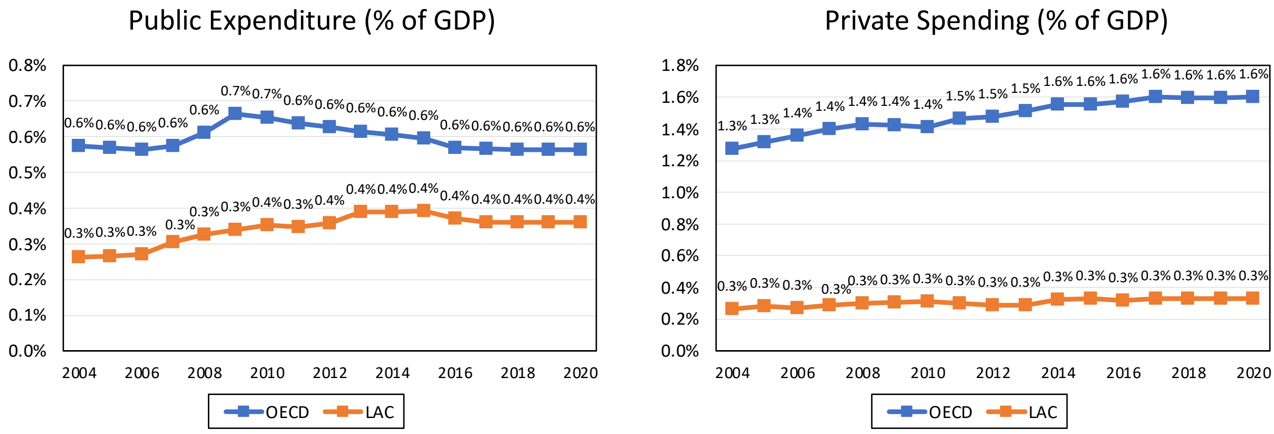
Graph 5-5. Latin America and the Caribbean vs. the OECD: Innovation Index (2004-2020)



Source: Telecom Advisory Services analysis

In 2004, the gap between the region and the average of OECD countries was 29.8 points, while in 2020 it increased to 37.1 points. One of the central factors determining the growth in the gap is the lag in private R&D investment (see Graph 5-6).

Graph 5-6. Latin America and the Caribbean vs. the OECD: R&D Investment

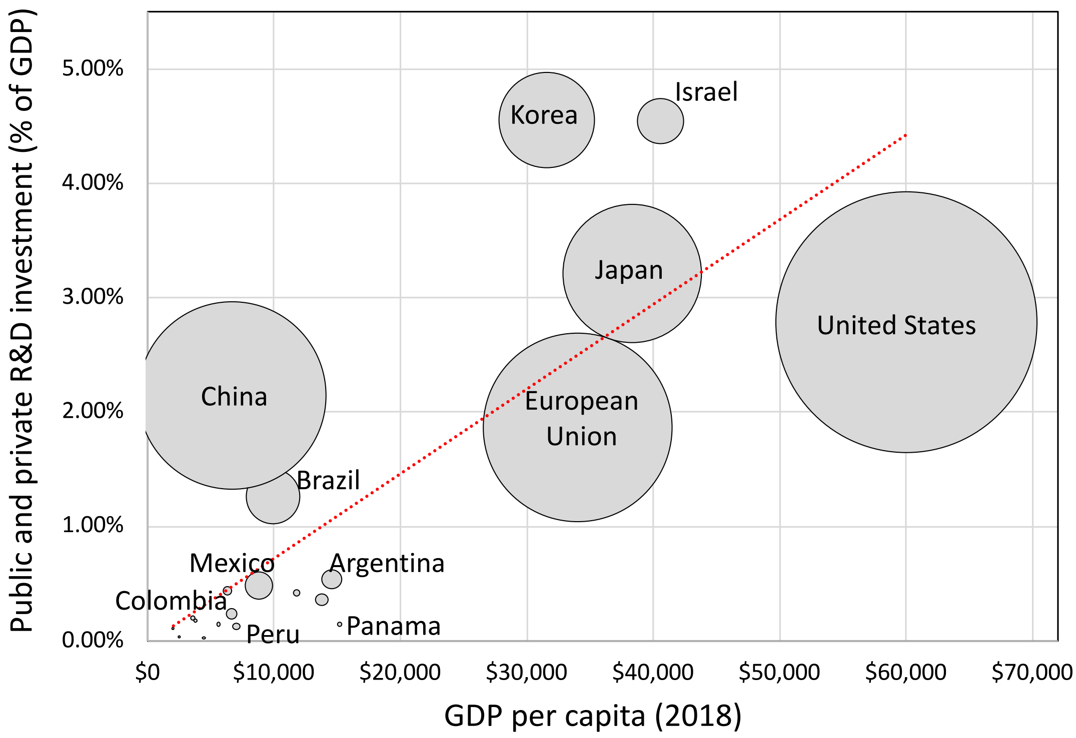


Source: UNESCO; Telecom Advisory Services analysis

It is worth mentioning that behind this innovation gap, digitization should play a significant role. Consequently, an increase in digitization levels will benefit the development of innovative activities.

In addition, the innovation gap is enhanced by economies of scale in R&D investment in absolute terms, as depicted in total R&D investment of some industrialized nations (see Graph 5-7).

Graph 5-7. Comparative public and private R&D investment (2018-9).



Note: the size of the bubble indicates the total annual investment in US$.

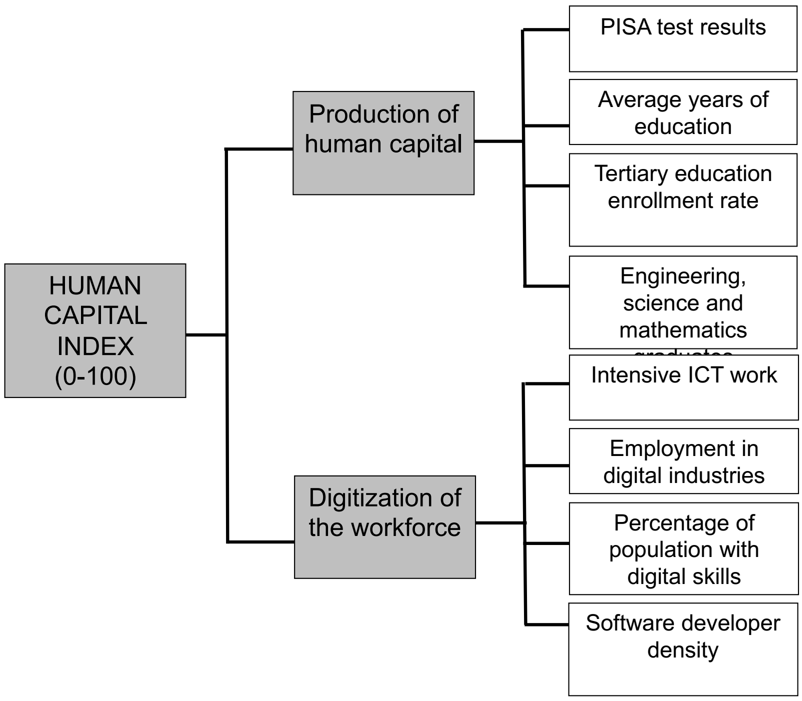
Source: UNESCO; World Bank; Telecom Advisory Services analysis

While recognizing the different size of the economies, the absolute values of R&D investment depicted in Graph 5-7 are representative of the challenge faced by Latin America and the Caribbean relative to the other countries. Public and private investment in Brazil, Mexico, Argentina, Chile. Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Honduras, Nicaragua, Panama, Paraguay, Peru, and Uruguay represents only USD 36 billion, compared to USD 572 billion for the United States, USD 296 billion for the European Union and USD 291 billion for China.[77]

5.4. Human capital development

As with the measurement of the level of innovation, the current situation regarding the development of human capital can be measured through an index that combines the quantity and quality of resources of human capital produced by the educational system with the training of the workforce (see Figure 5-3).

Figure 5-3. Structure of the Human Capital Index



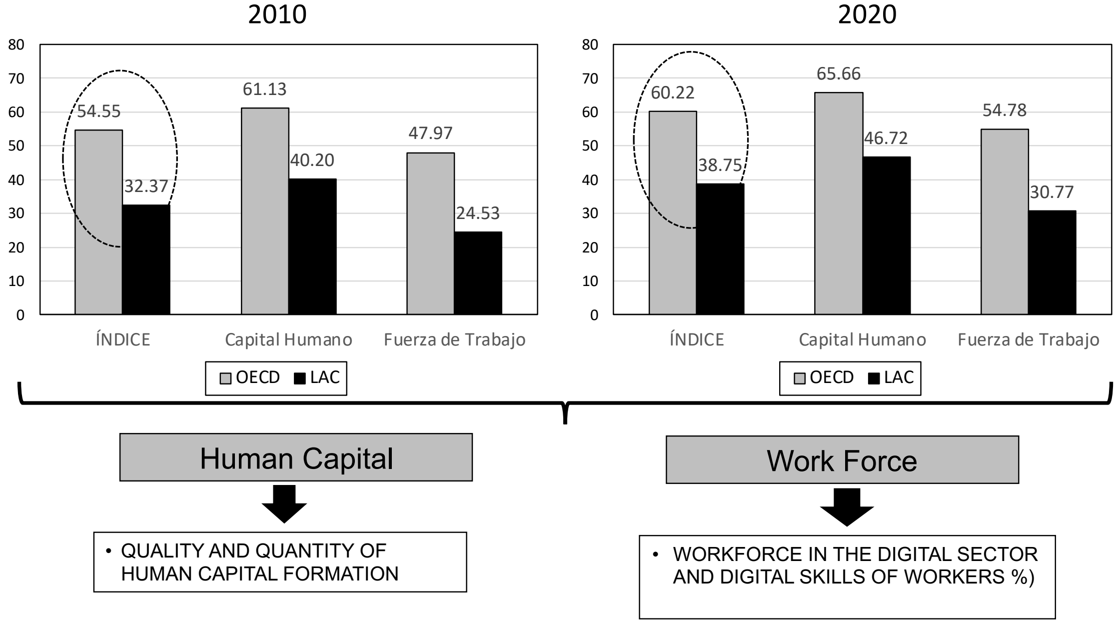
Sources: OECD; UNCTAD; UNESCO; ITU; Telecom Advisory Services analysis.

Contrary to what is happening in terms of investment in innovation, the gap between Latin America and the Caribbean and the OECD in terms of human capital has narrowed marginally, especially in terms of the production of talent (i.e., the quantity and quality of human capital formation). This trend indicates a certain convergence of the region with advanced economies. For example, Chile is graduating 2,619 per 1,000,000 inhabitants in STEM, and Colombia 2,237. These figures are very close to the OECD average of 2,237. The same occurs with the results of the quantitative module of the PISA test, in which Chile presents a value of 437 and Uruguay 424, values that are close to the OECD's 488.

[77] The latest values reported by UNESCO for each nation are those of 2018 and 2019.

On the other hand, perhaps reflecting a lag in the pace of digital transformation of Latin American economies, the gap in terms of digital workforce availability is widening, albeit marginally. This is not surprising given the inertia with which human capital statistics tend to evolve. Nevertheless, the index of availability of software programmers shows a significant lag between the region and advanced economies. Graph 5-8 presents the comparative indices for 2010 and 2020.

Graph 5-8: OECD versus Latin America and the Caribbean: Components of the human capital index



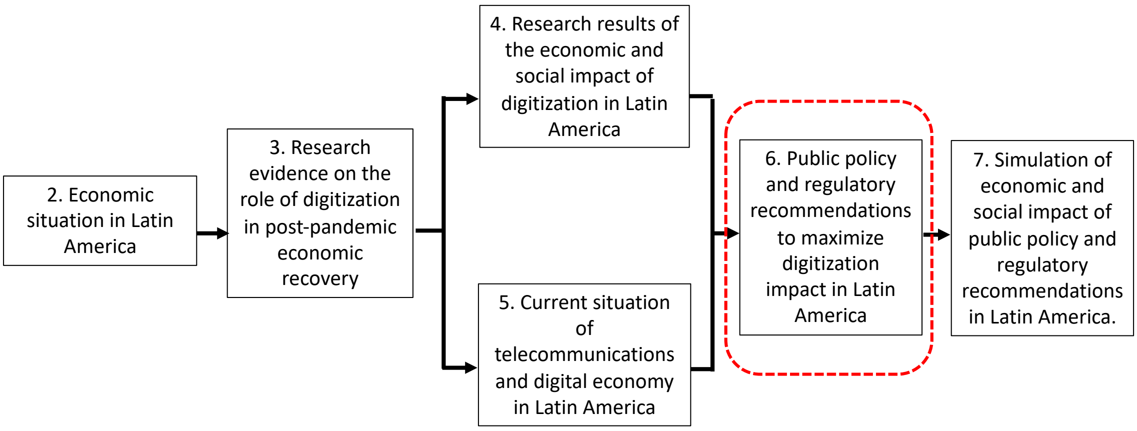
Sources: OECD; UNCTAD; UNESCO; ITU; Telecom Advisory Services analysis.

In summary, the development of human capital, a key component of growing digital economies, has made some progress and is less of a concern than the investment in R&D, making the definition of the incentives needed to accelerate it one of the major challenges facing the region.

6. RECOMMENDATIONS FOR MAXIMIZING THE DEVELOPMENT OF TELECOMMUNICATIONS AND THE DIGITAL ECONOMY

Chapter 4 presented empirical evidence that establishes the relevance of broadband and digitization for the economic recovery of Latin America and the Caribbean. As anticipated in its conclusion, the acceleration in the deployment of networks and the development of the digital economy can only be fulfilled through the implementation of public policy initiatives and regulatory and fiscal measures to facilitate such changes. Chapter 5 presented the current situation of telecommunications and the digital economy in the region to set the context in which public policy, regulatory and fiscal initiatives should be considered. This chapter presents recommendations aimed at accelerating the development of digitization and the digital economy (see Figure 6-1).

Figure 6-1. General framework of the study



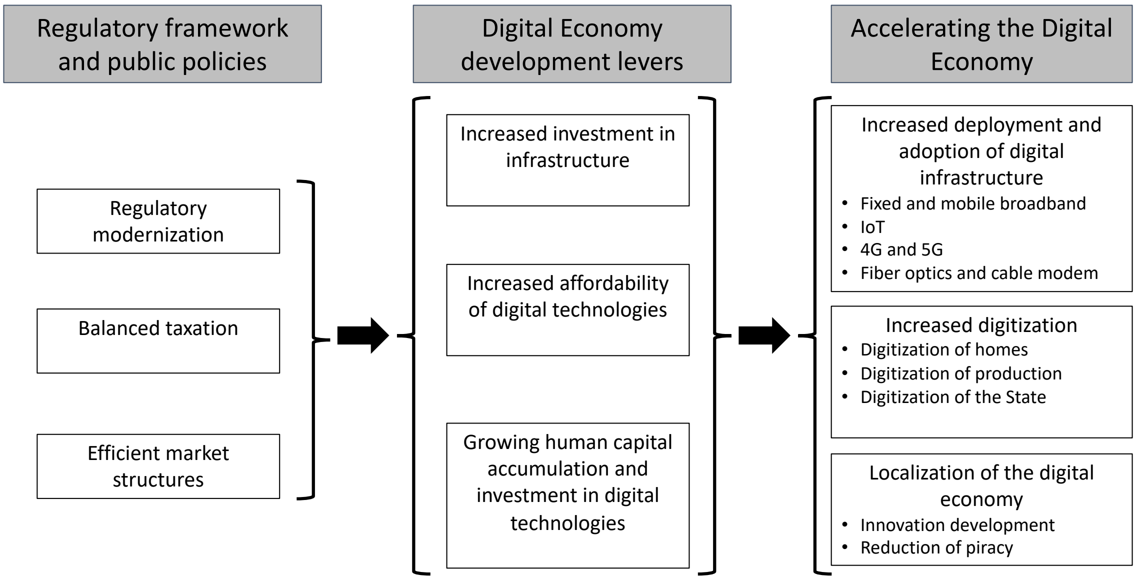
Based on international experience and best practices, the development of all the enablers that drive the acceleration in the deployment of telecommunications infrastructure and the advancement of the digital economy are conditioned by four types of initiatives:

- Modernization of the regulatory framework
- Deployment of a balanced taxation framework
- Consideration of an efficient telecommunications market structure
- Reducing piracy of audiovisual content

The starting point for the definition of these initiatives and measures is an analysis of international best practices and a series of interviews of regulators and policy makers in the region[78] (see Figure 6-2).

[78] In total, telecommunications regulators and policy makers in Bolivia, Colombia, Costa Rica, and Honduras were interviewed.

Figure 6-2. Conditions for maximizing telecommunications development



Source: Telecom Advisory Services

6.1. Regulatory modernization

A regulatory framework is defined as the mechanisms required to monitor and control an industry for the purpose of protecting consumers against the effects of monopolistic abuse, protecting investors, monitoring the performance of operators in terms of quality of service, and ensuring a sustainable environment. Regulation is, therefore, a means to obtain certain results, not an end in itself.

The study of regulation in the telecommunications industry and the digital economy has evolved with the development of the industry, from the protection of consumers in monopolistic contexts at the outset to the stimulation of competition and the development of incentives to generate static and dynamic efficiencies. Although regulators are often concerned with static efficiencies (related to lower prices), dynamic efficiencies are also important. These are linked to improving consumer choice (new products), performance and quality of offerings, and are related to capital investment. As mentioned above, if investment does not keep pace with traffic growth, service quality suffers. Similarly, if capital investment is not allocated to innovation, consumer choice decreases. The central issue here is to determine how the regulatory framework can impact the rate of capital investment in the sector.

6.1.1. Theoretical framework

Numerous studies have identified the relevance of the regulatory context in promoting the development of the telecommunications sector.[79] For example, there

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[79] See Katz, R. and Jung, J. (2021). *The impact of policies, regulation, and institutions on ICT sector performance*. Geneva: International Telecommunication Union, Ros, A.J. (1999). Does ownership or competition matter? The effects of telecommunications reform on network expansion and efficiency*.* *Journal of regulatory economics*, 15(1), 65-92, Li, W. and Xu, L.C. (2004). The impact of privatization and competition in the telecommunications sector around the world. *The Journal of Law and Economics,* 47(2), 395-430, Grzybowski, L. (2005). Regulation of mobile Telephony across the

is extensive literature that has identified a causal effect of competitive conditions on sector performance, through their impact on adoption, prices and innovation. Initially, this body of literature focused on the effects of privatizations of state-owned operators. Once the privatization stage was over, the focus of the empirical analysis shifted to the study of industry liberalization. Having generated sufficient evidence regarding the importance of competition, research turned to studying the effects of certain regulations aimed at creating a competitive environment, such as local loop unbundling. Examples of research in this area are Wallsten (2001 and 2006), Li et al. (2004), Ford and Spivak (2004), García-Murillo (2005), Distaso et al. (2006), Boyle et al. (2008).

Another body of the research literature has focused on the effects of competition on prices (for example, research by Grzybowski, 2005) or more specifically, on studying the impact of mergers on prices (Aguzzoni et al., 2015). With respect to the link between competition and innovation, empirical analysis has focused on access regulations and how they affect sector investment. Relevant contributions in this area are those of Alesina et al. (2005), Li et al. (2004), Wallsten, (2001), Jorde et al. (2000), Hausman (1999), Grajek and Roller (2012), Waverman et al. (2007), Friederiszick et al. (2008), Cave and Vogelsang (2003), Cave (2006), Cambini and Jiang (2009).

In turn, an important body of theory has been generated in the analysis of the role of radio spectrum policies and management, and their relevance for the mobile sector to offer quality services at affordable prices. Among the authors who have analyzed the role of spectrum management in pricing or adoption, we can highlight Zaber and Sirbu (2012), Bahia and Castells (2019), Kuroda and Forero (2017), Hazlett and Muñoz (2009), Park et al. (2011), and Bauer (2003). On the other hand, researchers also studied the impact of proper spectrum management on the maximization of investment and innovation levels (Bahia and Castells, 2019; Kim et al., 2011).

In sum, there is sufficient empirical evidence to demonstrate the impact of regulatory conditions on sector performance. The core question remains to the type of regulation that is most effective in growing sector capital investment. To this end, we will proceed to analyze to what extent the countries of the region are complying with a set of best practices identified at the international level, and how promoting regulatory changes that bring them closer to these best practices can impact the sector performance.

6.1.2. International regulatory best practices and recommendations for Latin America and the Caribbean

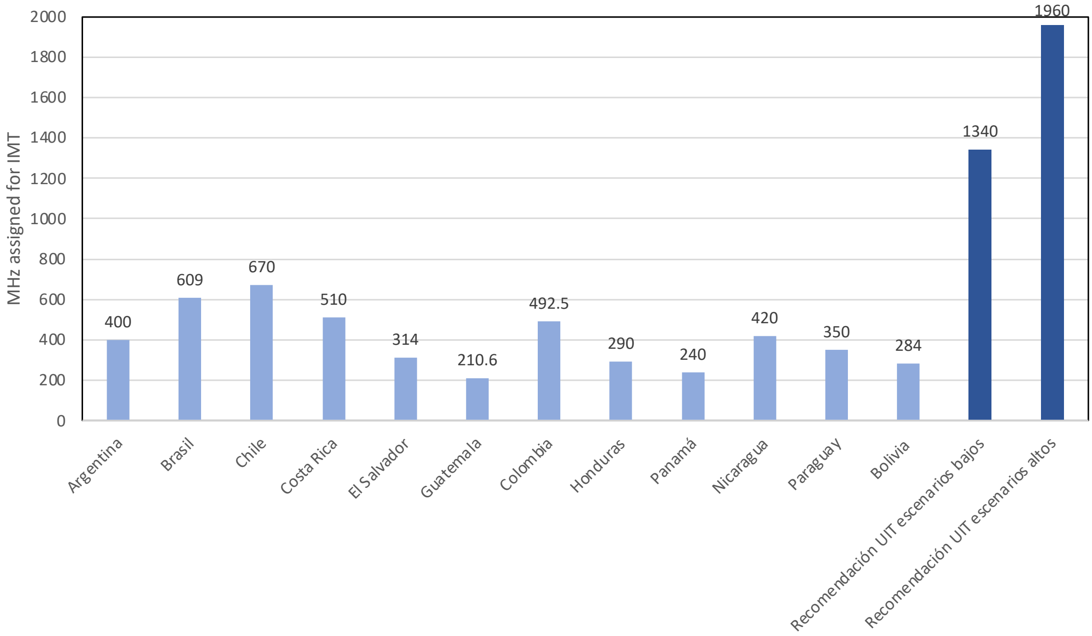
European Union: An Empirical Analysis, *Journal of Regulatory Economics*; 28:1 47-67, Distaso, W., Lupi, P., & Manenti, F. (2006). Platform competition and broadband uptake: Theory and empirical evidence from the European Union. *Information Economics and Policy* 18, p 87-106, Cava-Ferreruela I., & Alabau-Munoz A. (2006). Broadband policy assessment: A cross-national empirical analysis. *Telecommunications Policy* 30, 445-463, Wallsten S. (2001). An Econometric Analysis of Telecom Competition Privatization Competition Privatization and Regulation in Africa and Latin America" *The Journal of Industrial Economics*, XLIX, March 2001, Ford G., & Spiwak L. (2004). *The Positive Effects of Unbundling on Broadband Deployment*. Phoenix Center Policy Paper Number 19.

To identify best practices in regulatory matters, the ITU's *ICT Regulatory Tracker*, which analyzes regulatory regimes in more than 190 countries around the world, is used as a reference. The *ICT Regulatory Tracker* index is composed of 50 indicators grouped into four pillars: Regulatory Authority, Regulatory Mandate, Regulatory Regime, and Competitive Environment. The data are obtained from surveys conducted by the ITU with the regulatory authorities of each country, on an annual basis since 2007. The ITU's identification of good practices is based on the guidelines issued by the Global Symposium for Regulators (GSR) promoted by the ITU. This implies that these are good practices validated in the discussion forums of regulators at the global level. In particular, the Regulatory Regime and Competitive Environment pillars show the extent to which countries have adopted the best regulatory practices according to the ITU, making it a useful tool for measuring and comparing the state of regulation in each country. From the list of best practices established by the ITU in the *Regulatory Tracker*, we identified six specific ones, related to the general framework, licensing conditions, interconnection and competition.

In addition, we include an aspect not addressed by the *Regulatory Tracker* but which is of paramount importance for Latin America, namely spectrum availability and the resources paid to the State for spectrum usage rights. None of the countries surveyed are close to complying with the ITU's spectrum allocation recommendations for 2020 in different market environments (Figure 6-1). The international organization has stipulated spectrum requirements for 2020 of 1,340 MHz for a low market environment and 1,960 MHz for a high market environment.[80] Chile is the country that has allocated the most spectrum for IMT, although it barely covers 50% of the amount recommended by the ITU for the low-demand environment. At the other extreme, countries such as Guatemala and Panama do not even reach 20% of the recommended figures. The lack of spectrum could become a major bottleneck in the short and medium term. The need for greater amounts of this resource makes it essential to define roadmaps for the allocation of low, medium and high bands for the coming years, including spectrum for 5G. The scarcity of spectrum is also linked to a poor productive use of investments. This is explained by the fact that, to sustain demand, in the absence of spectrum, investments are made in towers that would not have been necessary if sufficient spectrum were available. As a result, the lack of spectrum makes services less affordable and takes away resources for network expansion to areas of low coverage or for technological renewal.

[80] ITU-R Report M.229022 of 2013

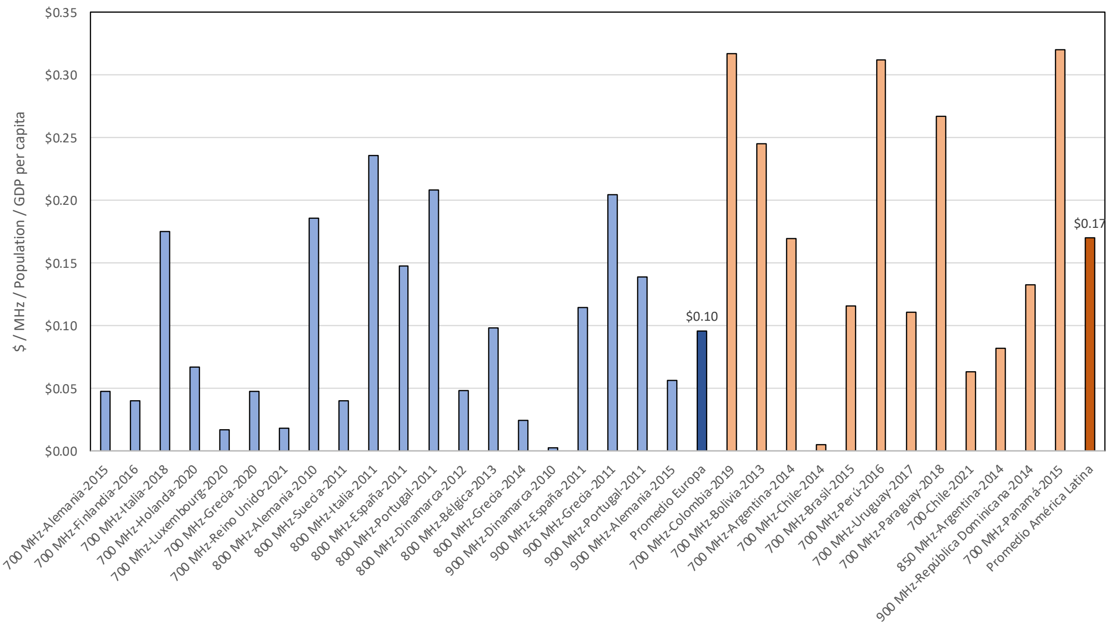
Graph 6-1. Spectrum allocated for IMT in Latin America (2021)



Source: 5G Americas

Another equally relevant aspect is that of spectrum prices. In general, countries in the region have paid significantly higher costs than advanced countries to access this resource. For comparative purposes, 87 spectrum tenders held in Europe and Latin America since 2010 have been surveyed. Adjusting for bandwidth, license duration, and differences in population and payment capacity (GDP per capita), it is possible to compare such values, which illustrate the excessive payments for this resource in Latin America.

Graph 6-2. Price paid for spectrum in low band contests (1 GHZ or lower)

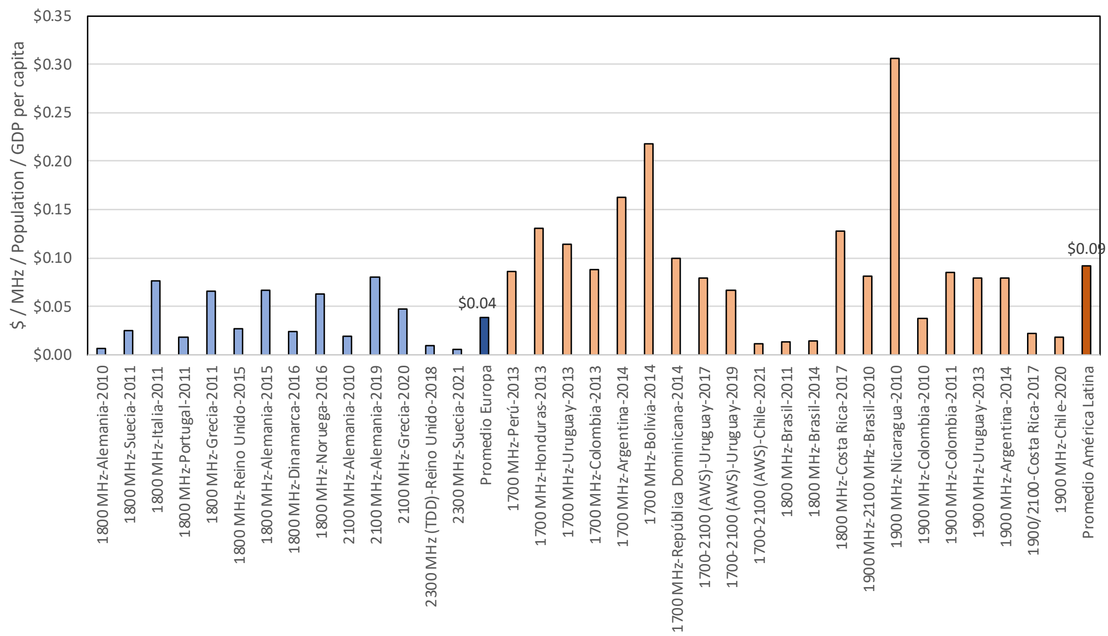


Source: information on MHz assigned and amounts resulting from auctions compiled from the media

Figure 6-2 data on auction prices in the low bands (1 GHz or less). On average, the cost of spectrum in Latin America is 1.7 times higher than in Europe. There are cases in the region for which this resource has reached very high levels, such as the 700 MHz band auctions in Panama (2015), Colombia (2019), Bolivia (2013), Peru (2016) and Paraguay (2018). On the other hand, it is worth noting that the price paid for the 700 MHz band in Argentina, Brazil and Uruguay is close to the European average, while the Chilean case stands out for the low costs of this resource, since the predominant mode of license assignment has not been auction, but a hybrid *Beauty Contest*, where operators compete for deployment projects. This type of mechanism is much more efficient in terms of ensuring investment and coverage.

A similar situation occurs in the middle bands (above 1 GHz but below 2.5 GHz). In this case, the cost of spectrum is more, on average, than twice as high as in Europe. High costs have resulted in the auctions carried out in 1700 MHz in Honduras (2013), Uruguay (2013), Argentina (2014), Bolivia (2014); in the 1800 MHz band in Costa Rica (2017), and in 1900 MHz in Nicaragua (2010) (Graph 6-3). At the other end, Chile and Brazil again stand out for their reasonable levels, even below the European average.

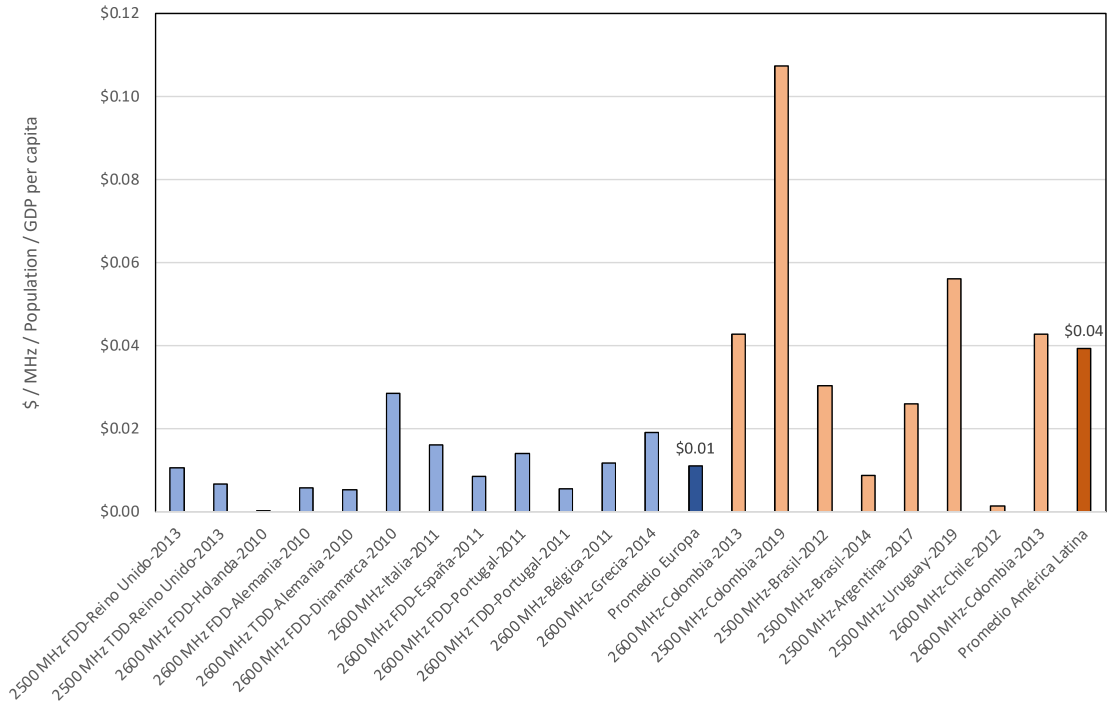
Graph 6-3. Price paid for spectrum in mid-band contests (between 1 GHZ and 2.5 GHz)



Source: information on MHz assigned and amounts resulting from auctions compiled from the media.

In the high bands, above 2.5 GHz (Graph 6-4), auctions have not been as frequent, but in the cases identified, the previous pattern is repeated: prices for spectrum are considerably higher than in European countries, by a very wide margin. Colombia and Uruguay stand out as cases of excessive prices, when considering the 2.5 GHz auction that both countries carried out. As in the cases of low and medium bands, Chile (2.6 GHz band in 2012) and Brazil (2.5 GHz band in 2014) stand out from the rest of the countries in the region for not extracting high auction payments.

Graph 6-4. Price paid for spectrum in high-band contests (above 2.5 GHz)



Source: information on MHz assigned and amounts resulting from auctions compiled from the media.

In summary, the measures identified as regulatory reforms, both from the *Regulatory Tracker* and those related to spectrum, are detailed in Table 6-1, together with the rationale justifying the relevance of each one.

Table 6-1. Regulatory modernization proposals

Policy	Proposed reform	Motivation	Examples of countries
General	To create a National Broadband Plan or Digital Agenda.	Beyond its own contents, this document sends a "signal" to operators about the fundamental importance of a digital strategy. At the same time, the development of the plan suggests political leadership, seeking consensus and coordination with all stakeholders to promote the deployment of infrastructures.	Australia, Canada, Germany, Hong Kong, Korea, Mexico, Singapore, Spain, Hong Kong, Korea, Mexico, Singapore
Operator licenses	Single or convergent licenses	Convergent licenses provide a flexible framework that facilitates innovation and maximizes opportunities for operators.	Belgium, Colombia, Finland, France, Iceland, Israel, United Kingdom, United States, United Kingdom, United States
Interconnection	Requirement to telecommunications operators to publish terms of reference for interconnection	This is a transparency measure for the wholesale market, which facilitates the development of agreements between operators.	Austria, Chile, Colombia, Croatia, Denmark, Estonia, Japan, Luxemburg, Vietnam, United Kingdom, United States, Uruguay and Venezuela.

Policy	Proposed reform	Motivation	Examples of countries
Spectrum management	Sufficient quantities at reasonable prices	Operators need to have sufficient amounts available to provide quality services, and such allocations should not be made for tax collection purposes, which compromises the availability of resources to deploy networks.	Germany, Chile, Holland
	Allowing spectrum transactions in the secondary market	The creation of a secondary market makes it possible to maximize the use of a scarce resource such as spectrum and makes it easier for it to end up in the hands of those who value and use it most.	Bulgaria, Cyprus, Greece, Guatemala, Hungary, India, Ireland, Sweden, Hungary, Ireland, Sweden
	Allow *refarming*	*Refarming* makes it easier for operators to reorganize the use of their assigned frequency bands, providing a flexible framework and maximizing spectrum utilization.	Bahrain, Brazil, United Arab Emirates, Netherlands, Italy, Latvia, Malaysia, Switzerland, Switzerland
Competition	Definition of Significant Market Power based on different criteria, beyond market share	The presence of an adequate regulatory framework to prevent anticompetitive practices is relevant to stimulate competition. However, market power goes far beyond market share, which is necessarily high in a concentrated sector. Other criteria that may have an influence are geography, control of essential facilities, access to financial resources, and economies of scale.	China, Colombia, Ecuador, Kuwait, Malta, Philippines, Portugal, Romania, Serbia, Serbia and Montenegro

Source: Telecom Advisory Services analysis

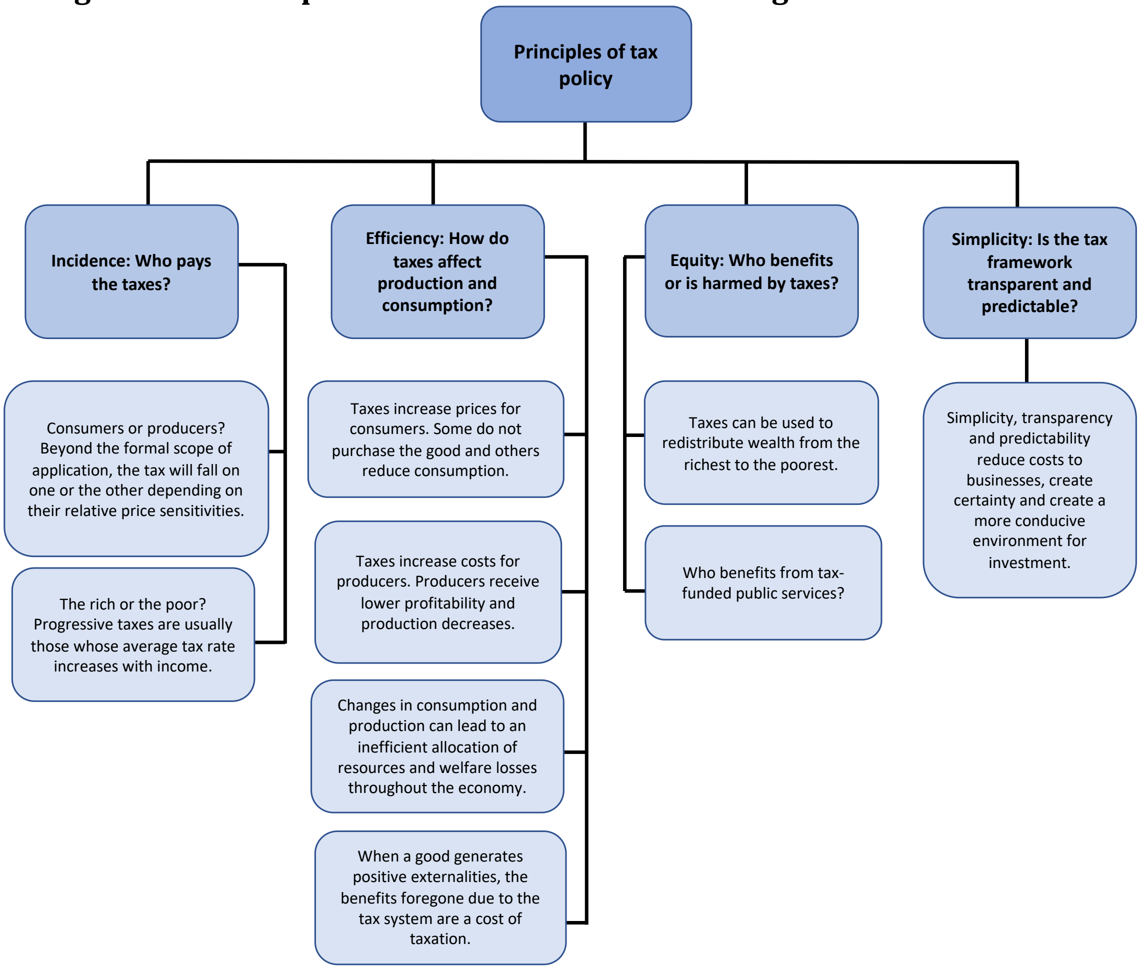
The measures identified cover both general aspects (broadband plan, licensing modality) and more specific elements, such as interconnection, spectrum management, or competition regulations. All the measures outlined in Table 6-1 should contribute to a better regulatory environment, and thus stimulate investment. This is particularly relevant in the case of spectrum pricing because it frees up resources that could be quickly poured into investment. This list does not include policies to fight piracy, e.g., better criminalization of piracy, along with other punitive measures, as this will be dealt with separately below. [81]

6.2. Balanced taxation

An effective tax policy must consider a series of factors to be balanced, ranging from the government's own fiscal needs, as well as avoiding inefficiencies and distortions that negatively affect market performance. Figure 6-3 summarizes the main principles to be considered.

[81] It should be noted that the measures included in the ITU *Regulatory Tracker* used to simulate economic impact do not coincide exactly with the recommendations identified above, since it is a general metric that does not include the details of each problem at the country level. Therefore, the simulations based on the *Regulatory Tracker* should be interpreted as a proxy for the country's short- and medium-term development potential based on regulatory improvements best practices.

Figure 6-3. Principles to be considered in the design of a tax framework



Source: adapted from Deloitte (2012).

A first element to consider is the **incidence** of a potential tax, i.e., who pays the tax. Beyond the taxed subject from a formal point of view, the tax will end up falling more on one or the other economic actor (seller or buyer) depending on their respective levels of price elasticity.

A second relevant attribute is **efficiency**. Taxes increase prices to consumers and costs to businesses, thereby reducing the quantities traded in the markets, as well as the resources available for investment. In this sense, an efficient tax system should be based on low tax rates applied across a broad tax base (and not the other way around). This minimizes the possible negative effects on consumers and businesses.

In line with the concept of efficiency, taxes should promote or discourage the generation of externalities, depending on whether these are positive or negative. Thus, economic theory suggests taxing in a reduced or moderate manner those services that are intended to stimulate their consumption, while increasing taxes on those goods that are understood to generate negative effects on society (such is the case of tobacco, alcohol, or gambling). It should be considered that the application of taxes generates an increase in the affordability barrier for consumers, by increasing acquisition costs. It is in this sense that the taxation applicable to the telecommunications sector should not be higher than the average of the sectors of the economy, and along these lines, the application of specific taxes generates inefficiencies by increasing prices and therefore reducing the level of consumption of services that should be stimulated, given the positive socioeconomic effects it generates.

One principle that tax schemes should follow is that of **equity**, understood both vertically (avoiding regressive effects on the most vulnerable sectors) and horizontally (companies with similar characteristics should be taxed in an equivalent manner). In this sense, specific taxes on the acquisition of ICT services tend to generate inequities in the regressive-vertical sense, since they affect all consumers, regardless of their income level.

Finally, it is important to highlight another relevant attribute of any tax framework, such as **simplicity**. Simplicity is associated with characteristics such as transparency and predictability. These properties are desirable to the extent that they reduce costs for companies, generate certainty and create a more favorable environment for investment.

While the primary objective of a tax framework is to generate funding to support the cost of public service provision, taxes can be introduced to satisfy other objectives such as protecting domestic industries, or to capture funds for specific public policy objectives (e.g., bridging the digital divide). To satisfy such objectives, nations, and sub-sovereign entities (provinces, municipalities) introduce a host of taxes, fees and permits to maximize objectives of different types.

Sales taxes are considered as an alternative tax to raise revenue, as certain administrations rely primarily on this tax to avoid collecting income tax. In addition, certain taxes may be introduced to reduce the consumption of certain goods and services (e.g., liquor, tobacco, and high-end automobiles). Alternatively, certain taxes may be modified by exemptions to facilitate the acquisition of goods by economically vulnerable population.[82]

Import tariffs are imposed in principle to protect developing domestic industries until they make progress in creating comparative advantages, to defend strategic industries (such as steel, armaments, and energy), to protect non-renewable resources, or to limit anti-competitive practices. These are calculated as a percentage of the *ad valorem* import price.

In general, the tariff implies an increase in the purchase price of the good, with the natural erosion of consumer surplus. However, it is important to recognize that such a reduction must be weighed against the gain in producer surplus resulting from the protection of local industries, as well as the creation of jobs. Research shows, however, that the reduction in consumer surplus because of the tariff tends to be greater than the producer surplus. For example, the increase in the purchase price of the good may result in a decrease in the rate of diffusion of advanced technologies.

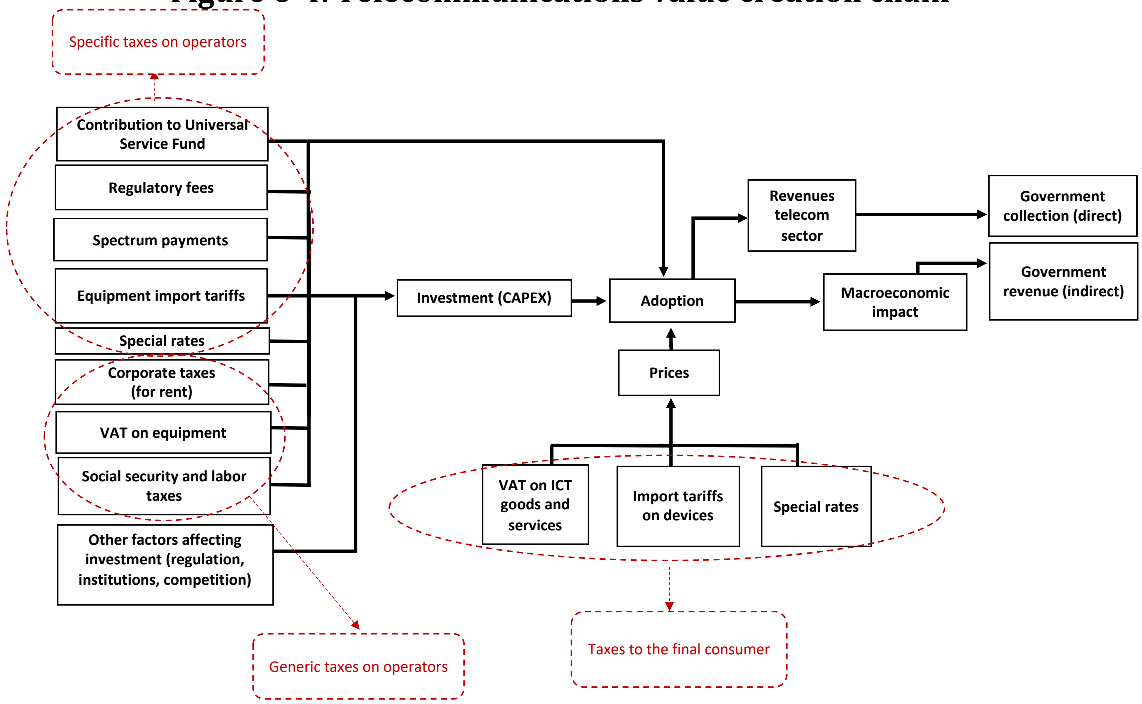
[82] See Katz, R. & Callorda, F. (2015). *Experiencia de planes subsidiados o con tarifas sociales*. Study commissioned by the Ministry of Telecommunications and the Information Society of the government of Ecuador.

Finally, specific taxes can be introduced to raise funds for specific public policy objectives. These taxes are advantageous in terms of their predictability and low transaction costs, although by increasing the purchase price they may affect the consumption of certain goods by the economically vulnerable population. From an institutional perspective, these taxes present a difficulty in terms of being able to be allocated to the objective for which they were conceived, which can be used to finance other activities of the State.

6.2.1. Theoretical framework

The diagram shown in Figure 6-4 summarizes how the different types of taxes affecting telecommunications operators are placed within the framework of a sector value creation chain.

Figure 6-4. Telecommunications value creation chain



Source: Telecom Advisory Services

As illustrated in Figure 6-4, taxation generates an economic impact depending on who receives the tax. Consumer taxes (such as those levied on the purchase of telecommunications devices or services) increase the total cost of technology ownership, which has an impact on penetration through the elasticity of demand. In other words, technology adoption is a function of the total cost of access to the technology. However, a tax that affects demand also has an impact shared by the operator insofar as the latter must still deploy networks without necessarily being able to maximize their use. This can be seen in the diagram as an impact of adoption on the sector's revenues, which, in turn, will have an impact on future investments.

On the other hand, taxes or charges levied directly on the operator, such as spectrum fees, affect technology deployment to the extent that they influence the amount of capital invested. The compensatory nature of the value added tax eliminates an important part of this influence. Therefore, it is important to differentiate all taxes to understand whether they impact consumption or production, before or after operating margins and EBITDA to fit the tax theory.

6.2.2. Emerging debates worldwide

The massification of the Internet and the convergence phenomenon have prompted debates on taxation applicable to digital ecosystem players worldwide. In this regard, the BEPS project[83] refers to the initiative promoted by the OECD to design fairer international taxation, while addressing tax planning practices used by multinational companies to take advantage of loopholes and inconsistencies in national tax frameworks and transfer their profits to low-tax countries.

On the other hand, recent transformations within the digital ecosystem have generated new debates, such as the sustainability of investments in infrastructure and, related to this, the need to generate more horizontal mechanisms of fiscal contribution from the digital ecosystem to the states. Such debates have emerged both in Europe[84] and in the United States[85] . A recent proposal developed by US FCC Commissioner Brendan Carr[86] , linked to the funding mechanism of Universal Service Funds (USFs), stands out. Traditionally, USFs have collected resources from the telecommunications industry to finance broadband deployment in areas that are not commercially profitable, such as rural areas. That model, according to Commissioner Carr, is obsolete. He argues that the dominant telecommunications network is no longer telephony (the original USF scope), but the Internet, which leads to the need to rethink how to finance high-speed networks in unprofitable environments. Carr proposes to include internet platforms as potential contributors. The argument is that, just 5 companies - Netflix, YouTube, Amazon Prime, Disney+ and Microsoft - account for 75% of rural broadband internet traffic in the United States (Layton and Potgieter, 2021[87]), and most of the investments are to add capacity and adapt networks to support such streaming services.

6.2.3. International experience in the taxation of the telecommunications sector and recommendations for Latin America and the Caribbean

The application of taxes, charges and levies in the telecommunications sector is not homogeneous worldwide. There are various models of taxation applied to the telecommunications sector, defined mainly around the public policy objectives related to the sector. In general and depending on the tax burden applicable to both

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[83] Acronym for *Base Erosion and Profit Shifting.* More information at: https://www.oecd.org/tax/beps/

[84] Álvarez-Pallete, J.M., Höttges, T., Read, N. & Richard, S. (2022). Letter: Europe's telecoms market risks falling behind rivals. Financial Times (February 14). Available at: Available at: https://on.ft.com/34POTou

[85] Reardon, M. (2021). FCC commissioner pushes for Big Tech to pay to close digital divide. CNET (June 2). Available at: https://www.cnet.com/home/internet/fcc-commissioner-pushes-for-big-tech-to-pay-to-close-digital-divide/

[86] Carr, Brendan (2021). Ending Big Tech's Free Ride | Opinion. Newsweek (May 24). Available at: https://www.newsweek.com/ending-big-techs-free-ride-opinion-1593696

[87] Layton, R., & Potgieter, P. H. (2021). *Rural Broadband and the Unrecovered Cost of Streaming Video Entertainment*. Forthcoming, ITS Gotenberg June.

operators and consumers, at least two models can be identified: 1) A reduced taxation model to stimulate adoption and investment, and 2) A model to maximize government revenues.

The reduced taxation model to stimulate adoption and investment focuses on reducing taxes on operators to maximize investment and reducing consumer levies for the acquisition of devices and services to lower the total cost of ownership for consumers, thereby stimulating the adoption of mobile services. This model is characterized by a moderate VAT rate (less than 20%) on the acquisition of devices, and a total tax liability to operators of less than 10%. In the opposite model of government revenue maximization, sector-specific taxes are introduced not only on services but also on devices in order to maximize government revenues, with a consequent distortionary and discriminatory impact. In this case, VAT to consumers is equal to or higher than 20%, and tax obligations to operators are equal to or higher than 10%. Figure 6-5 presents the map in which these models and examples of countries associated with them can be identified.

Figure 6-5. Fiscal models for the telecommunications sector

			Taxes to final consumers		
			VAT ≤ 10%.	10% < VAT < 20%.	VAT ≥ 20%.
			Reduced taxation. Demand incentives.	Moderate consumption taxation	High consumption tax burden
Operator taxes	Tax obligations to operators < 10% of revenues	Low taxation. Exemptions / investment incentives. No or moderate contribution to FSU.	- United States - Singapore - Australia - South Korea	- Germany - Canada	- United Kingdom - Norway
	Tax obligations to operators ≥ 10% of income	Regulatory fees above administrative costs. Contribution to FSU around 1% or more.	- United Arab Emirates		- France - Saudi Arabia

Reduced taxation model to stimulate adoption and investment

Government revenue maximization model

Source: Telecom Advisory Services

Based on this framework, figure 6-6 presents the position of Latin American countries (for which information is available).

Figure 6-6. Latin America: Fiscal models for the telecommunications sector

			Taxes to final consumers		
			VAT (+ excise tax) ≤ 10%.	10% < (VAT and excise tax) < 20% and absence of other specific taxes	VAT (+ excise tax) > 20% or > 10% with additional excise taxes
			Reduced taxation. Demand incentives.	Moderate consumption taxation	High consumption tax burden
Operator taxes	Tax liabilities < 10% of income	Low taxation. Exemptions / investment incentives. No or moderate contribution to FSU.	- Paraguay	- Chile - Guatemala	
	Tax obligations ≥ 10% of income	Regulatory fees above administrative costs. Contribution to FSU around 1% or more.		- Mexico - Peru	- Brazil - Argentina - Ecuador - Uruguay - Dominican Rep. - Colombia - Honduras

Reduced taxation model to stimulate adoption and investment

Government revenue maximization model

Source: Telecom Advisory Services

The only countries in the region that can be associated with the reduced taxation model to encourage adoption and investment are Paraguay, Chile, and Guatemala. In terms of taxes applicable to consumers, Paraguay's tax authority charges a VAT of 10%, with no additional specific taxes. Chile and Guatemala also have moderate VAT (19% and 12%, respectively), and no specific consumption taxes (except for a pay TV tax in Guatemala).

With respect to taxes applicable to operators, while the data are not precise enough to estimate the exact total amounts paid in Paraguay and Chile, the research carried out leads to the conclusion that it is low, probably below 10% of the operators' revenues. For example, Paraguay (along with Panama) has the lowest corporate income tax in the region (10% of profits), and the regulatory rate is moderate (0.88% of gross revenues). The contribution to the Universal Service Fund is included in the regulatory rate. With respect to Chile, while the corporate income tax is 25%-27% of profits, labor contributions are very low, and neither universal service fund contributions nor regulatory fees apply.

At the other end, the remaining countries in the region have consumer taxes higher than 10%. For example, Panama, while it has a 7% VAT, adds a 5% selective consumption tax, thereby exceeding the recommended threshold. From an operators' perspective, according to GSMA data[88] for the mobile segment, Brazil, Argentina, Dominican Republic, Ecuador, Mexico[89] , Uruguay, Honduras, Colombia and Peru have a total taxation (considering both general and specific taxes) higher than 10% of revenues.

[88] GSMA (2017). *Taxing mobile connectivity in Latin America. A review of mobile sector taxation and its impact on digital inclusion.*
[89] GSMA (2015). *Digital inclusion and mobile sector taxation in Mexico.*

In general, it can be said that most countries in the region tend to follow a revenue maximization model, which limits the possibilities for adoption and investment in telecommunications.

Our recommendations for the sector are summarized in Table 6-2. The underlying objective is to eliminate asymmetries and distortions (i.e., taxes above the average for other sectors of the economy), and to stimulate investment and the adoption of ICT services.

Table 6-2. Proposed Reforms to the Tax Framework

Rate / Tax	Proposed reform	Impact	Motivation
Sum of regulatory fees	Reduce up to 0.5% + FSU of maximum 1%.	Reducing the rate by one percentage point (e.g., from 1.5% to 0.5%) increases investment by 1.6%.	The regulatory fee should be reduced to exclusively cover the costs of regulation. The FSU should not exceed 1%[90] .
Specific taxes on mobile services	Eliminate (only general VAT will apply)	Reducing the rate applicable to ICT services by one percentage point (e.g., from 15% to 14%) reduces prices by a similar magnitude, which increases adoption.	Eliminating specific taxes that tax the consumption of ICT services above other goods makes it possible to reduce intersectoral asymmetries.
Equipment tariffs	Delete	Elimination of tariffs on equipment increases investment by 14.7%.	Eliminating tariffs on equipment allows for increased investment.
Smartphone tariffs	Delete	The elimination of tariffs on smartphones increases the adoption of ICT services by 22.4%.	Eliminating tariffs on equipment increases the adoption of ICT services.

Source: Telecom Advisory Services

6.3. Reducing content piracy in the audiovisual industry

The concept of piracy encompasses multiple dimensions, such as piracy of online audiovisual content or illegal connectivity to pay TV services. This section analyzes the impact of piracy prevalent in the digital content production industry.

A report published by Cet.la analyzed online piracy patterns for 10 countries in the region from November 2019 to March 2020[91] , seeking to measure the availability and audience of online audiovisual content piracy. The study concluded that 35% of the URLs analyzed from the search for topics related to online audiovisual content lead to illegal services or content. The same effect happens with 33% of the results in Social Networks and 26% in Marketplaces. In terms of economic losses, the study author estimates what would happen if a percentage of the piracy audience consumed legal services, estimating that legal services in Latin America have a potential annual revenue loss of at least USD 733 million. The study also estimates

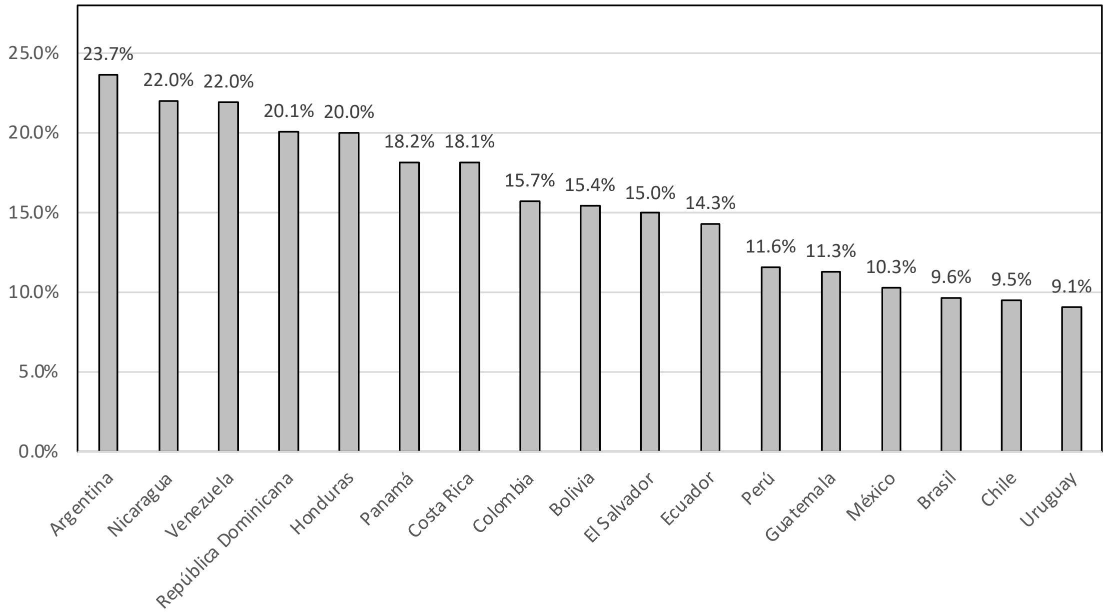
[90] The 1% threshold is taken as a reference based on the analysis of best practices in digitally advanced countries. For example, in Australia, Canada, France and the United Kingdom, contributions are less than 1%, while in countries such as Germany, Korea and Singapore there is no obligation to contribute to a USF.

[91] Arrigón, R. (2020). *Dimension and impact of online piracy of audiovisual content in Latin America*. Montevideo: Cet.la.

that the illicit business represents a potential profit loss of at least USD 675 million per year, based on the average number of clicks on illegal sites.

Beyond online impact, piracy also drives illegal connectivity to pay TV services, either by signal theft or under-reporting, modalities that are widespread in the region, causing considerable economic damage. The main problem when it comes to economic analysis of these forms of piracy is the lack of public data that provide reliable metrics on an ongoing basis. The only available data are those provided by the Alliance for Piracy, which through surveys carried out for the years 2015 and 2018, estimate the number of households per country that have pirate pay TV connections (either by signal theft or under-reporting) (Graph 6-1).

Graph 6-1. Pirate TV Connections / Household, 2018 (%)



Source: Alliance Against Piracy

According to the latest available data, the countries with the highest impact of piracy are Argentina, Nicaragua, Venezuela, Dominican Republic, and Honduras, all of them with more than 20% of households with this type of connection. Even in countries with lower levels of piracy, the problem is far from being minor, since the number of households affected is estimated at around 10% (Brazil, Chile and Uruguay). Pay TV piracy is therefore a problem that is widespread in Latin America and requires decisive action from regulation and public policy to minimize its effect.

The 2018 Alliance Against Piracy study has estimated the losses generated by this problem, based on calculating what would happen in terms of sectoral revenues and jobs if all these users were to sign up for a legal pay TV connection (Table 6-3).

Table 6-3. Estimated losses from piracy of pay TV connections (2018).

Country	Annual losses of pay TV providers (USD millions)	Programmers' annual losses (USD million)	Loss of jobs
Argentina	$680.48	$279.40	5605
Bolivia	$58.22	$29.01	816
Brazil	$1,448.59	$477.22	11783
Caribbean	$10.29	$6.07	
Chile	$93.11	$46.64	924
Colombia	$247.50	$114.33	4223
Costa Rica	$39.50	$24.24	521
Ecuador	$62.81	$34.66	982
El Salvador	$23.77	$16.45	502
Guatemala	$30.66	$19.77	919
Honduras	$25.10	$14.42	801
Mexico	$293.66	$147.85	5895
Nicaragua	$17.44	$10.02	513
Panama	$23.80	$16.23	351
Peru	$143.55	$58.81	1677
Puerto Rico	$19.25	$9.01	214
Dominican Republic	$63.59	$36.08	1282
Uruguay	$19.16	$13.58	251
Venezuela	$379.73	$177.28	3201
Total	$4783.51	$1821.82	48582

Source: Alliance Against Piracy (2018)

According to the estimates in Table 6-3, the losses are very significant, estimating a total of USD 4,783.5 million for the entire Latin American and Caribbean region in losses by service providers, to which it should be added USD 1,821.8 million in programming revenues and 48,582 jobs. The losses are also significant in terms of tax revenue for the state (Table 6-4).

Table 6-4. Estimated tax revenue losses from piracy (2018).

Country	Tax collection losses (USD million)
Argentina	$282
Brazil	$401
Chile	$42
Colombia	$197
Ecuador	$30
Peru	$73
Uruguay	$13
Venezuela	$104
Total	$1,142

Source: Alliance Against Piracy (2018)

It is important to note that there are examples worldwide of countries that have updated their regulatory frameworks to combat piracy. For example, in Spain[92] the Penal Code establishes that illicit practices of manipulating decoder devices to access encrypted content free of charge and without consent are illegal, even for the

[92] Satcesc (2021). *Pirating pay-TV has its legal risks*. March 6. Available at: https://satcesc.com/2021/03/06/piratear-television-pago-riesgos-juriidicos/

consumers themselves, for whom penalties of fines are foreseen. In Latin America, we can mention the case of Colombia[93] , where the penalty of imprisonment and fine is established for anyone who receives, broadcasts, or distributes by any means, without prior authorization, the TV signal. Within online piracy, there are also examples of good practices to highlight. For example, in France, the *HADOPI Law* aims to regulate and control the Internet to prosecute intellectual property infringements. Another possible practice is to enable operators to block IPs immediately upon detection of such practices.

In addition, resolutions and recommendations on combating piracy in the Americas were recently agreed upon during the 39th meeting of the CCP.I of the OAS – CITEL.[94] Among the measures recommended, one should mention the need to adopt a legal and regulatory framework aimed at preventing, detecting and combating piracy, the adoption or strengthening of channels of complaint, as well as the incorporation of monitoring equipment to detect irregularities in order to combat piracy of content and television signals.

6.4. Structure of efficient markets

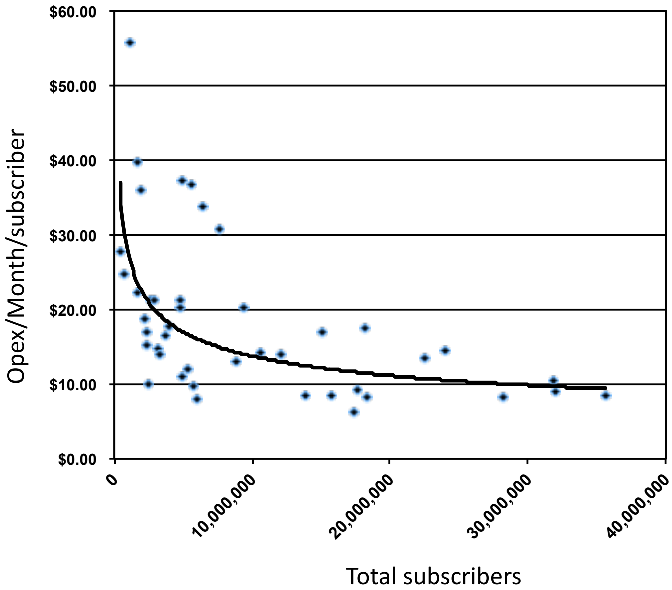
Economic analysis has shown that in capital-intensive industries such as telecommunications there is an optimal degree of industrial concentration that generates benefits for consumers while ensuring sector sustainability. This postulate is supported for three reasons:

- Significant economies of scale of service providers
- Operational efficiency of large operators
- Increased infrastructure investment and deployment capacity

Along these lines, all analyses of the cost structure of the telecommunications industry conclude that economies of scale are significant (see, for example, Graph 6-2, which shows the operating cost economies of scale (OPEX) of mobile operators in North America and Europe).

[93] Week (2014). *Beware if your TV signal is pirated*. January 30. Available at: https://www.semana.com/tenga-cuidado-su-senal-television-pirata/373934-3/
[94] Full document available at: https://www.citel.oas.org/en/SiteAssets/PCCI/Final-Reports/CCPI-2021-39-5164_e.pdf

Graph 6-2. Mobile Operators in Europe and North America: Economies of Scale in Telecommunications



Sources: Bank of America; Telecom Advisory Services analysis

Based on high economies of scale, increased profitability in telecommunications results from optimized use of infrastructure and economies in input procurement, among other effects. Operators with a larger subscriber base have a significant cost advantage over smaller operators. These economies of scale are mainly determined by the infrastructure component in the cost structure. Also, the return to scale is multiplied by the fact that mobile services represent a single product industry, essentially leveraged by volume. Finally, it is also possible that the economies of multi-plant operations (multiple customer care, maintenance, and logistics centers) may also have some impact.

In this sense, moderate competition is conceived as the model that allows increasing the stimulus to capital investment to the extent that, in contrast to the open and unrestricted competition model, it allows the operator to assume an adequate rate of return. The argument is based on the premise that a certain level of market power is necessary to stimulate an adequate level of investment and innovation.[95]This point of view is based on the seminal work of Philippe Aghion and his collaborators at Harvard University on the concept of the so-called inverted 'U'[96] . This establishes that the relationship between competition and innovation is not linear, but rather resembles an inverted 'U' that describes that innovation and investment increase with the growth of competition up to an optimal point of moderate competition, after which, if competition intensifies, the incentive to innovate (and therefore to

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[95] This is the same argument that underlies the need for the system of intellectual protection through patents to secure investment and stimulate innovation.

[96] See Aghion, P., Bloom, N., Blundell, R. Griffith, and Howitt, P. "Competition and innovation: and inverted-U relationship", *Quarterly Journal of Economics*, 120(2): pp. 701-728, 2005. Actually, the idea of the inverted-U relationship between competition and innovation was first identified by Scherer, F. Market Structure and the Employment of Scientists and Engineers. *American Economic Review*, 57(3): pp. 524-531, 1967.

invest, as an intermediate variable) begins to diminish. The reason for this dynamic relationship is that, if the expectation of higher profitability is the cause of the incentive to innovate, the indiscriminate increase in competition (and the consequent reduction in profitability) reduces the incentive to innovate. The objective is to determine the optimal point of competition that maximizes the incentives to innovate and invest.

6.4.1. Theoretical framework

Turning now to the telecommunications sector, the hypothesis guiding this study is that, based in part on high economies of scale, competition among a limited number of vertically integrated operators would be moderate and therefore close to the optimal concentration point that maximizes investment and innovation. Even if competition is known to be an important factor in market dynamics to promote investment and innovation, the nature of the telecommunications sector (with large fixed and sunk costs) makes this relationship complex. Returning to the optimal point of industry concentration argued by the "inverted U" theory, economic research has sought to determine what is the optimal number of participants in a market that maximizes static (pricing) and dynamic (innovation) efficiencies while ensuring a certain degree of profitability for the sector. Starting with Selten (1973), who stipulated that "four is too few and six is too many," the range has been progressively revised over the years until Huck et al. (2004) lowered such thresholds, stating that four players may be too many (i.e., could lead to a sub-optimal market outcome). Consequently, the optimal market structure in the telecommunications sector, in terms of maximizing consumer surplus, economic impact and industry sustainability, is approximately three infrastructure operators. This number of players ensures sufficient competitive intensity to generate a maximum amount of consumer welfare (lower prices, but more importantly, good services). Therefore, the "inverted U" theory helps understand the link between the number of firms and the generation of economic efficiencies.

Empirical evidence supports this. For example, for mobile telecommunications, Friesenbichler (2007) has found an inverse-U relationship between concentration and investment, claiming that there is an optimal level of concentration. In particular, he argues that, in fragmented markets, a higher level of concentration may be desirable to encourage investment. Similarly, Houngbonon and Jeanjean (2016)[97] find a U-inverted relationship between the margin obtained by mobile operators and the level of investment, with a sample of 2,770 observations for the period 2005 to 2012. According to the authors, investment is maximized when gross profits represent between 37 and 40% of operators' revenues. These thresholds can be expected to be higher in the case of countries with a higher level of risk (e.g., exchange rate), as is the case of Latin American countries. On the other hand, Genakos et al (2015) analyze the impact of the number of operators in the mobile market, the entry and exit of operators, as well as the effect of the degree of concentration on investment, using OECD data for the period 2006-2014. The evidence found by the authors suggests that a 10% increase in the HHI increases investment per operator by more than 20%. Meanwhile, Jeanjean (2013) has found

[97] Houngbonon, G. V., & Jeanjean, F. (2016). What level of competition intensity maximises investment in the wireless industry? *Telecommunications Policy*, *40*(8), 774-790.

evidence that when competitive intensity is very high, firms may invest below desirable amounts, because the expectation of returns on investment is deteriorated. Kang et al (2012)[98] have found a positive relationship between market concentration and investment level in the mobile segment in China. Moreover, Grajek (2012)[99] has found evidence that access regulation to facilitate the entry of new entrants negatively affects the incentives to invest in fixed broadband. Similarly, the results of Bacache, Bourreau, and Gaudin (2014)[100] have found no evidence that access regulation increases new entrants' investment in fixed broadband.

6.4.2. Digital ecosystem and changes in relevant markets.

The presence of an increasingly diverse and transformed digital ecosystem based on the phenomenon of convergence has eroded traditional market boundaries, making them much more diffuse, both in terms of services and connectivity infrastructure. For example, voice, messaging, and audiovisual services are now provided by very different platforms located in different spaces of the digital ecosystem, which compete with each other. In terms of connectivity, the technological solutions capable of offering high-quality services are increasingly diverse (and vary according to geographical area), ranging from fixed connectivity (fiber, ADSL, cable), mobile, satellite or wireless ISP solutions.

For all the above reasons, whether analyzed from the point of view of services or access, traditional ways of measuring competition levels, such as the Herfindahl index based on telecommunications operators' market shares, are becoming increasingly meaningless. For example, is it really a competition problem if there are only two mobile operators in a country, if they also compete with other types of connectivity networks, and the services they provide compete with those of global Internet platforms? Given the characteristics of the current digital ecosystem, this may not be a problem, given that users are gaining economic benefits and choice. Moreover, it is possible that consolidation is a necessary element in these conditions, where returns on investment are threatened by these increasingly cross-cutting levels of competition. Such considerations should be considered when analyzing efficient market structures in the countries of the region.

6.4.3. International experience and recommendations for Latin America and the Caribbean

The international experience shows that moderate concentration in telecommunications markets stimulates capital investment and acts as an incentive to reduce prices in the medium term (see Table 6-5).

[98] Kang, F., Hauge, J. A., & Lu, T. J. (2012). Competition and mobile network investment in China's telecommunications industry. *Telecommunications Policy*, *36*(10-11), 901-913.
[99] Grajek, M., & Röller, L. H. (2012). Regulation and investment in network industries: Evidence from European telecoms. *The Journal of Law and Economics*, *55*(1), 189-216.
[100] Bacache, M., Bourreau, M., & Gaudin, G. (2014). Dynamic entry and investment in new infrastructures: Empirical evidence from the fixed broadband industry. *Review of Industrial Organization*, *44*(2), 179-209.

Table 6-5. Impact of market consolidation on investment and prices

Country	Case (year)	Structure (2018)	Impact on investment	Price impact
Australia	Merger of the third and fourth operators (2009)	• Telstra (50.64%) • Optus (31.20%) • Vodafone (18.16%)	• Increase from US$ 1,220 in 2009 to US$ 2,059 in seven years	• Marked reduction in mobile telephony between 2010 and 2012 • Secular trend of price reduction in mobile band, although less significant
Germany	Merger of the third and fourth operators (2014)	• O2 (40.75%) • T-Mobile (31.88%) • Vodafone (27.38%)	• Increase from US$ 3,802 in 2013 to US$ 4,152 in 2015.	• Mobile telephony price reduction started one year before the merger • Decrease in mobile broadband prices occurred simultaneously with the merger
Japan	Merger of the third, fourth and fifth operators (2010-15)	• KDDI (41.29%) • NTT Docomo (38.40%) • Softbank (20.31%)	• Increase from US$ 11,889 million in 2000 to $17,067 million in 2013, decreasing to $11,166 million in 2018.	• After the mergers, voice plan prices decreased while data plans increased to resume the discipline altered by the unrestricted competition of five operators. • In 2017 that prices began to decline
Portugal	Exit of the fourth operator (2010)	• Altice MEO (39.83%) • NOS (30.54%) • Vodafone (29.64%)	• Increased from US$ 253 million in 2000 to $668 million in 2011, reaching $745 million in 2013, stabilizing around $700 million	• Voice and data prices were increased after the exit to resume the discipline altered by the unrestricted competition of four operators. • Between 2012 and 2013, prices began to decline.

Source: Telecom Advisory Services analysis

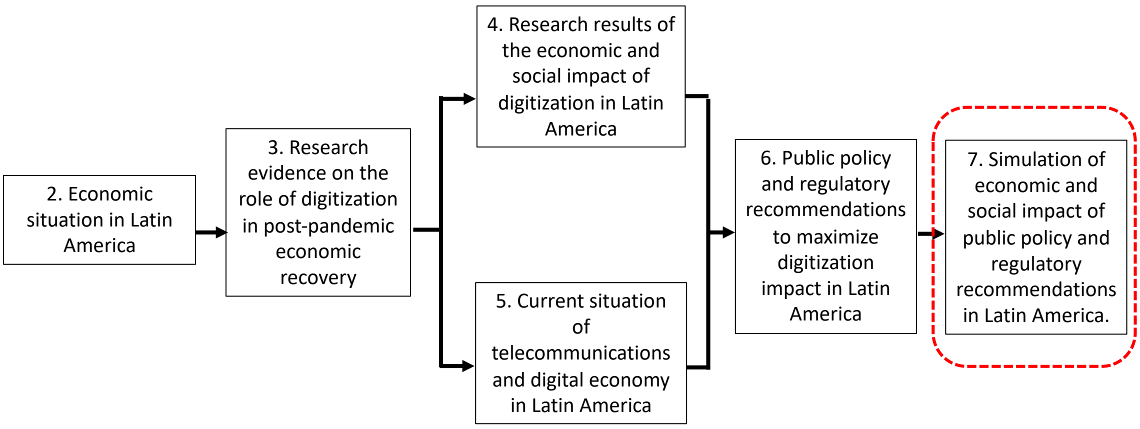
The analysis of these four cases indicates that market consolidation results in increased capital investment and lower prices, although these may occur with a lag depending on specific conditions. For example, in situations of highly competitive intensity (or the presence of a maverick), the effects do not occur immediately because the remaining players in the market must re-establish financial discipline before they begin to compete on price or increase their investment. An additional element to consider when determining the appropriate number of operators is the size of the market, since a three-operator structure may not be optimal in the case of very small countries.

7. SIMULATION OF THE IMPACT OF PUBLIC POLICIES AND REGULATION ON ECONOMIC RECOVERY IN LATIN AMERICA AND THE CARIBBEAN

Chapter 6 presented recommendations based on the international experience for the implementation of public policy initiatives and regulatory and fiscal measures in the telecommunications and digital industries to accelerate the economic recovery in Latin America and the Caribbean. The next chapter presents the results of impact simulations in three categories of initiatives:

- Modernization of the regulatory framework
- Implementation of a balanced tax framework
- Consideration of efficient market structure

Figure 7-1. General framework of the study



7.1. Impact of regulatory modernization

As a starting point, we analyzed the current situation in twelve countries in the region in terms of the regulatory recommendations identified in Chapter 6. The data used as a basis for the analysis are those provided by the *ICT Regulatory Tracker* of the International Telecommunication Union and interviews conducted with local regulators[101] and telecommunications operators.

[101] In total, telecommunications regulators and policy makers in Bolivia, Colombia, Costa Rica, and Honduras were interviewed.

Comparing the current position of each country with the potential in the event of complying with good practices according to the *Regulatory Tracker*'s regulatory regime section, all the countries surveyed have potential for improvement, given that in no case are they complying with all the recommendations identified in Table 6-1. However, the starting points for reform differ considerably among countries. For example, in Chile only two of the recommendations are identified as not being met (the one referring to the absence of single or general licenses, and an insufficient amount of assigned spectrum), so the margin for potential improvement is very limited in this case. At the other end, countries such as Guatemala and Panama have ample room for improvement, since they are only in compliance with two of the measures identified. Table 7-1 shows the current score in the Regulatory Tracker index, and the potential that each country could obtain if it complies with all the good practices in Table 7-1. [102]

7-1. Latin America: Changes in the *Regulatory Tracker* due to regulatory modernization

Country	Current Index	Potential Index
Argentina	72.50	76.50
Bolivia	62.50	67.50
Brazil	92.00	96.00
Chile	87.00	89.00
Colombia	84.00	86.00
Costa Rica	85.00	89.00
El Salvador	70.00	75.00
Guatemala	57.00	64.00
Honduras	79.00	81.00
Nicaragua	70.67	76.67
Panama	79.50	86.50
Paraguay	63.83	69.83

Source: ITU; Telecom Advisory Services analysis

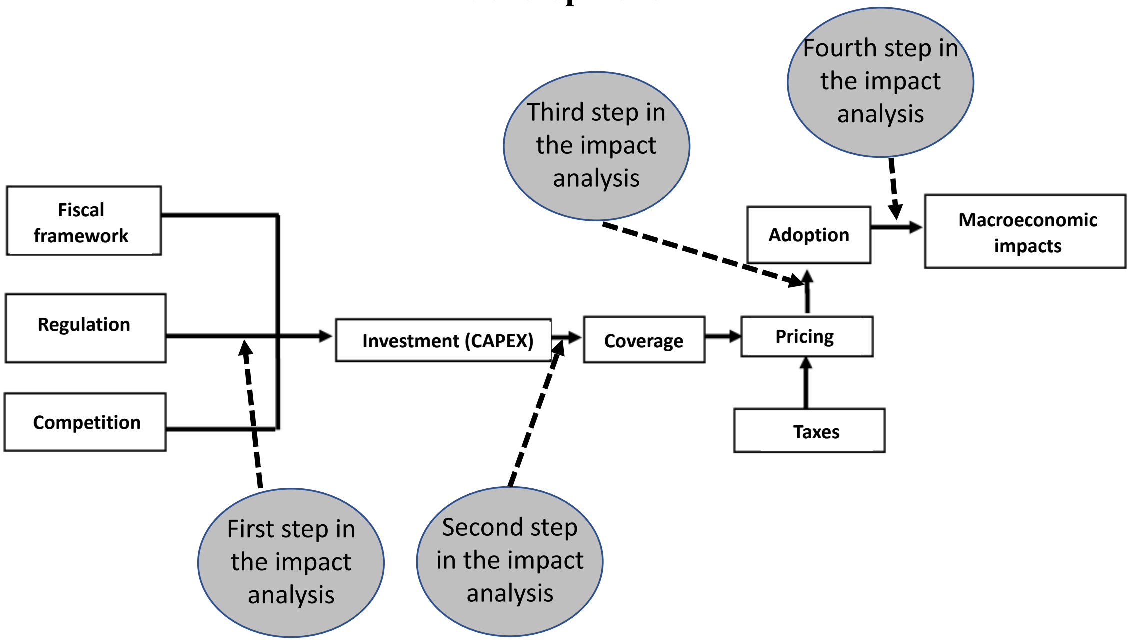
One aspect in which all countries are lagging is radio spectrum. None of the countries surveyed is close to complying with the ITU's spectrum allocation recommendations for 2020 in different market environments. In terms of prices, 50% reductions in the cost of this resource are proposed for those countries in the region that have charged the highest spectrum prices in the auctions reviewed in the previous chapter (the reference is the imposition of charges higher than the regional average in low, medium, or high band auctions), and 25% for the remaining countries. As an exception, no reduction in spectrum prices is simulated for Chile, since this country has charged lower prices than the European average in the auctions reviewed, largely thanks to the *Beauty Contests* mechanism.

The impact analysis resulting from the introduction of the regulatory improvements presented in Table 7-1 considers the possibility that these will generate higher levels of investment, which, in turn, are expected to contribute to increasing

[102] As mentioned in note 81, it is worth mentioning that the measures included in the *Regulatory Tracker do* not coincide exactly with the limitations identified above, since it is a general metric that does not include the details of each problem at the country level. Therefore, the simulations based on the *Regulatory Tracker* should be interpreted as a proxy of the country's short and medium-term development potential based on regulatory improvements based on best practices.

coverage, reducing prices, and stimulating adoption. This has required a disaggregated analysis structured around four steps, as detailed in Figure 7-2.

Figure 7-2. Impact of changes in the regulatory framework on sector development



Source: Telecom Advisory Services analysis

Step One: Impact of regulatory modernization on capital investment

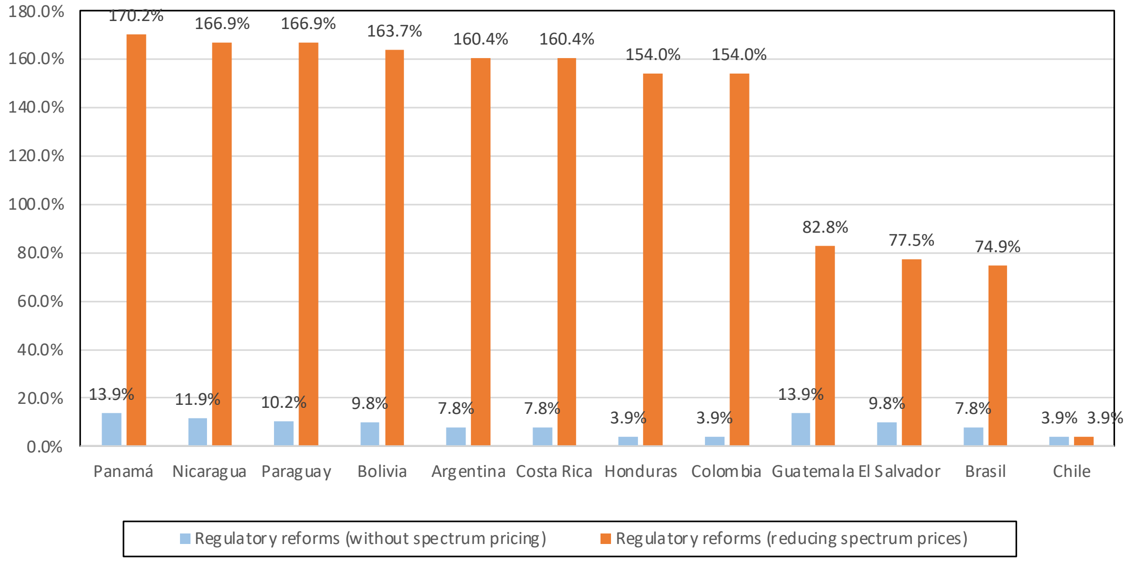
In order to estimate the potential increase in telecommunications capital investment as a result of the regulatory reform recommendations represented in Table 6-5, we used the econometric estimates presented in Annex 12 (model VI), which identify that each point increase in the *Regulatory Tracker* index is associated with an increase in telecommunications CAPEX of 1.7%.[103] Accordingly, depending on the potential points of increase in the index (from the levels stipulated in Table 7-1) it is possible to identify how much CAPEX would increase as a consequence of the regulatory reforms.

Regarding the impact of the change in spectrum prices, we consider the estimates made by Bahia and Castells (2021)[104] , which associate a 1% reduction in spectrum prices with a 0.45% increase in 4G coverage in developing countries. Combining this elasticity with the regressions linking coverage with CAPEX (Annex 13), it is possible to calculate what would be the resulting investment at the time of a spectrum price decrease that would generate such an impact on coverage. The estimates were made only for the mobile telecommunications segment (due to the availability of coverage data).

[103] This model was developed for 145 countries for the period from 2008 to 2019, with a total sample of 875 observations.
[104] Bahia, K., & Castells, P. (2021). The impact of spectrum assignment policies on consumer welfare. *Telecommunications Policy*, 102228.

Graph 7-1 shows the potential increases in mobile capital investment, considering the implementation of regulatory reform recommendations, and distinguishing the effect of incorporating the reduction in spectrum prices. For this purpose, cumulative effects are considered within a 5-year period (considering the inertial effects that lead to the fact that the investment each year affects the CAPEX of the following year).

Graph 7-1. Cumulative increase in mobile CAPEX as a result of regulatory reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

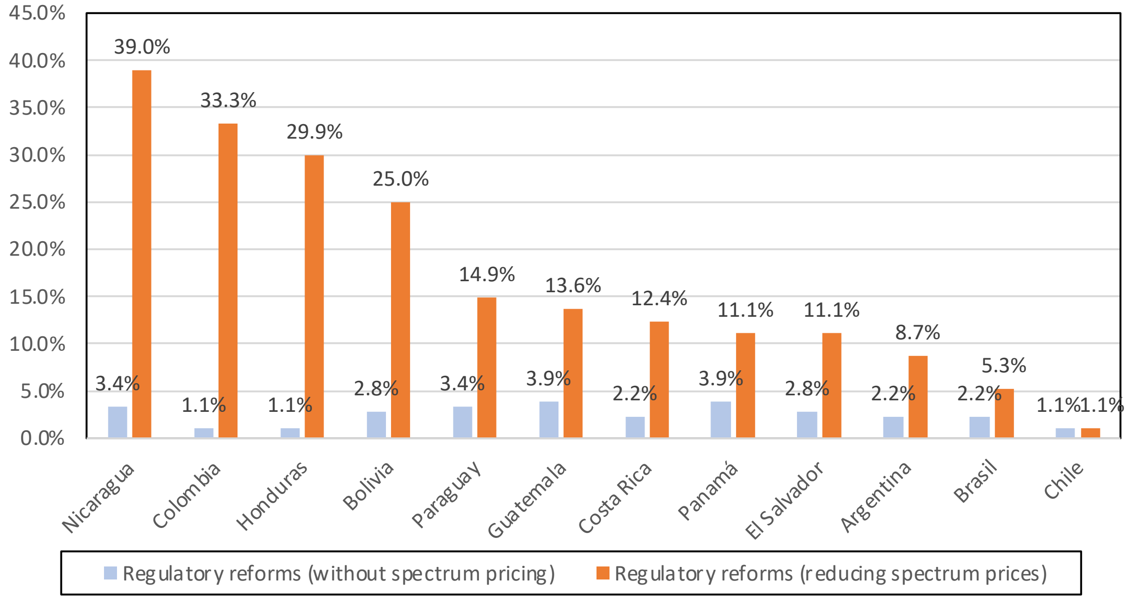
One aspect that is clear from Graph 7-1 is that spectrum price reductions are key to stimulating investment: the impact of regulatory measures without including spectrum costs is significantly lower. Naturally, for those countries where a deeper spectrum price reduction has been simulated, the impact is higher. Particularly noteworthy are the cases of Panama, Nicaragua, and Paraguay, which could achieve increases of more than 166% in investment in the cumulative period of 5 years. On the other hand, in the case of Chile (to cite an opposing example), it would only be modernizing the licensing framework, given that the country already complies with the remaining practices, including low spectrum charges. This implies that investment growth for this country would be modest: around 3.9%.

Step 2: Impact of increased capital investment on mobile coverage

To estimate the impact of investment on coverage levels, the econometric regression presented in Annex 13 is used as a reference, where it is estimated that 1% increase in CAPEX generates an increase in 4G coverage of 0.23% two periods ahead.[105] Therefore, the jump in coverage reported in Graph 7-2 will tend to be greater in countries where the increase in CAPEX has been greater.

[105] This model was developed for 108 countries for the period from 2009 to 2018. The total sample is 487 observations.

Graph 7-2. Increase in 4G coverage as a result of regulatory reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

In particular, 4G coverage would increase 39% in Nicaragua, 33% in Colombia and 30% in Honduras, cumulatively for the 5 years of the period considered. The reason why some countries with a high increase in investment in Graph 7-1 appear relatively relegated in Graph 7-2 is because they are countries whose coverage growth potential is more limited as they are closer to the 100% ceiling (as in the case of Panama, Paraguay, or Argentina). Once again, the enormous potential for lowering spectrum costs is highlighted. Naturally, in Chile the coverage increases would be the smallest (1.1%).

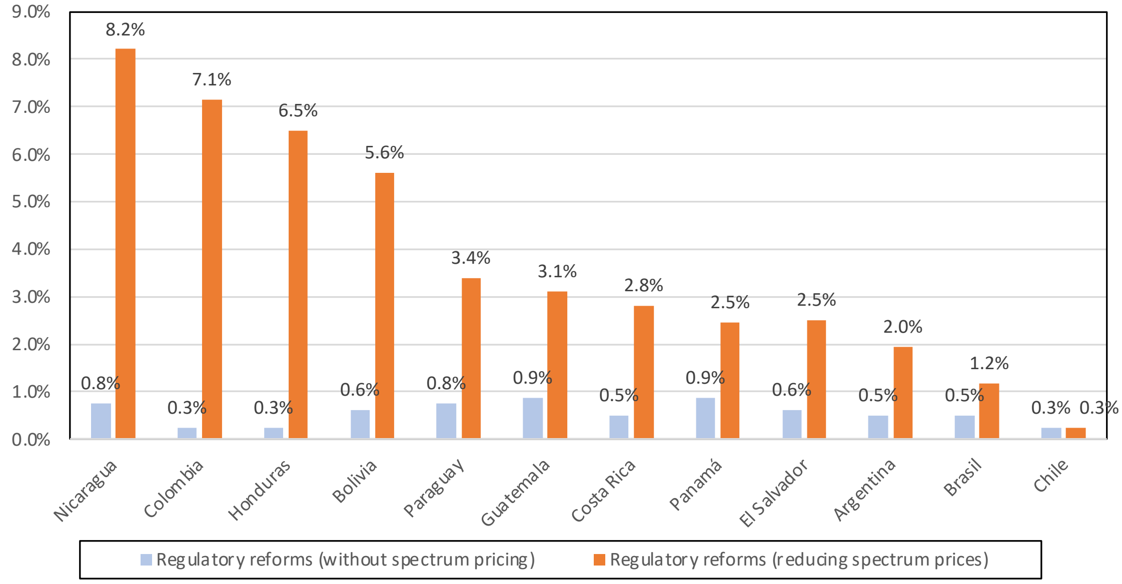
Step 3: Impact of mobile service price declines on mobile broadband penetration

Increases in coverage will generate a reduction in prices, which, in turn, will generate increases in mobile broadband penetration because of the calculated elasticity coefficient that indicates that for every 1% reduction in prices, penetration will grow by 0.5% (Graph 7-3).[106]

Once again, these increases are more pronounced in countries where reforms have been more profound.

[106] This model was developed for 108 countries for the period from 2009 to 2018. The total sample is 524 observations.

Graph 7-3. Increase in unique mobile broadband subscribers as a result of regulatory reforms (cumulative from t to t+5)

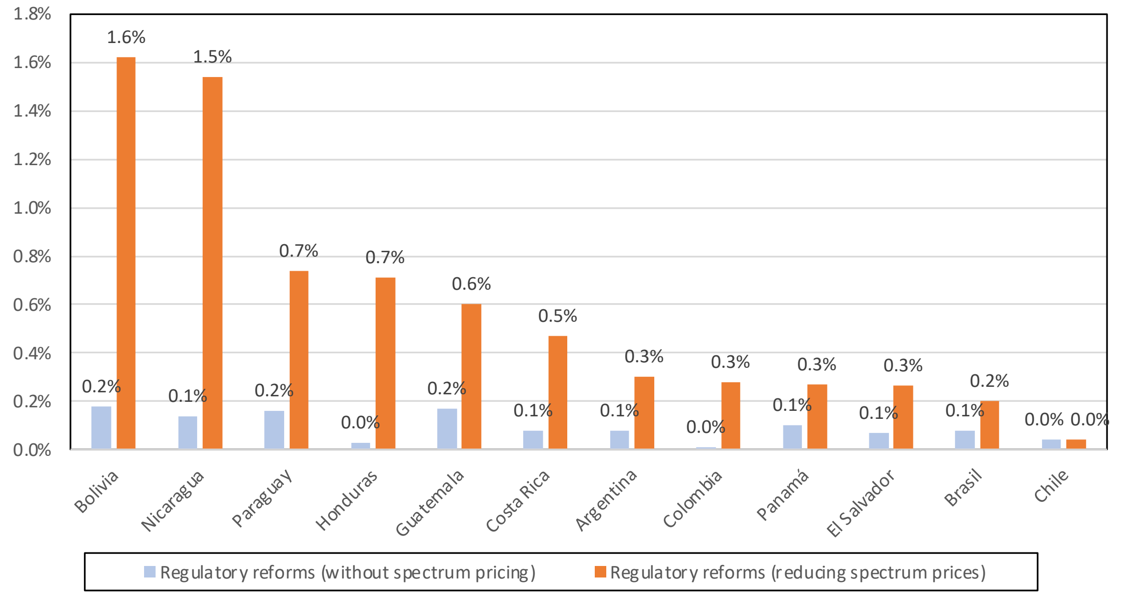


Source: Telecom Advisory Services analysis

Step 4: Impact of increased mobile broadband penetration on GDP per capita

Higher levels of adoption will translate into increases in GDP per capita. As seen in Chapter 4 (Figure 4-11), a 10% increase in mobile penetration is associated with a 1.7% growth in GDP per capita in Latin America. Given that in each country the increases in penetration are disparate (as shown in Figure 7-3), Graph 7-4 shows the expected changes in GDP per capita over 5 years because of regulatory reforms.

Graph 7-4. Increase in GDP per capita due to regulatory reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

In Bolivia, GDP per capita would grow by 1.6%, while in Nicaragua it would grow by 1.5%. In other cases, such as Chile and Brazil, the economic impact of regulatory modernization will be lower.

7.2. Impact of changes in the taxation framework

As in the case of regulatory modernization, beyond the support of the countries that have adopted the tax modernization initiatives mentioned in Chapter 6, it is worth analyzing what the impact would be if they were implemented in the region. As a starting point, Table 7-2 summarizes the current situation in twelve countries of the region in the recommendations for modification of the tax framework identified in Chapter 6. It should be noted that, given the limitations of the available data, we are considering as the sum of regulatory fees only the license fee paid to the regulator, the contribution to the USF, activation or numbering fees, and security taxes. In other words, we are not including all regulatory contributions since we do not have consistent data by country for all of them (e.g., spectrum payments). The data are based on official documentation and interviews with local regulators and telecommunications operators.

Table 7-2. Current Status of the Tax Framework

Tax		Sum of regulatory fees	Specific taxes on mobile services	Equipment tariff	Smartphone tariffs
Argentina	Current value	1.50%	26.26%	7.90%	2.10%
	Proposal	1.50%	21%	0	0
Bolivia	Current value	2.29%	16%	9.80%	
	Proposal	1.50%	13%	0	0
Brazil	Current value	2.50%	28.74%	12.90%	10.70%
	Proposal	1.50%	17.80%	0	0
Colombia	Current value	2.06%	23%	0%	0%
	Proposal	1.16%		0	0
Costa Rica	Current value	3.25%		0%	0%
	Proposal	1.50%	13%	0	0
El Salvador	Current value	0.10%	13%	0%	0%
	Proposal	0.10%	13%	0	0
Guatemala	Current value	0.02%	12%	0%	0%
	Proposal	0.02%	12%	0	0
Honduras	Current value	2.73%		0%	0%
	Proposal	1.50%		0	0
Mexico	Current value	0%	16%	4.20%	0%
	Proposal	0%	16%	0	0
Nicaragua	Current value	1.42%		20% excise tax	20% excise tax
	Proposal	0.78%		0	0
Panama	Current value	2.44%	12%	0%	0%
	Proposal	1.50%		0	0
Paraguay	Current value	1.00%	10%	2.90%	1.95%
	Proposal	1.00%	10%	0	0

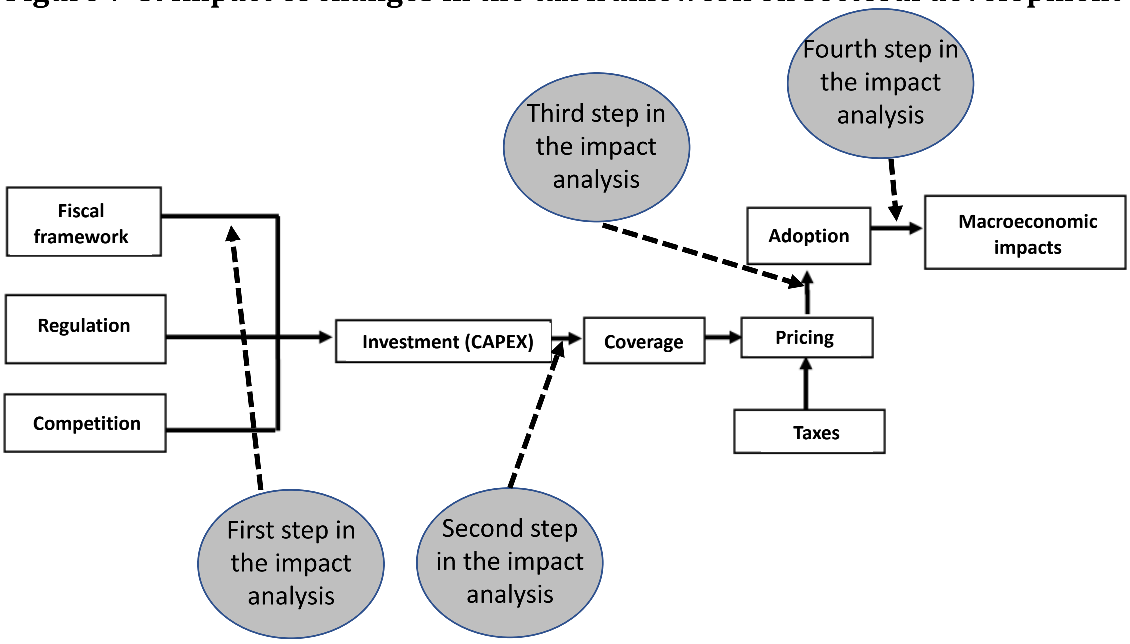
Source: ITU, GSMA, WTO, operator interviews, Telecom Advisory Services.

It is worth noting that, given the different starting points of each country, the reforms to be introduced will be of different magnitude in each case (Table 7-2). It is even worth noting the case of Guatemala or El Salvador, countries that already meet the objectives indicated for each tax segment, so in that case there are no reforms to simulate.

Bolivia and Brazil are the countries in the sample where tax changes are the most profound, because they affect all four segments identified. These are countries with high regulatory fees, with specific taxes on ICT services, and which impose tariffs on the import of both equipment and devices.

In the same way as in the case of recommendations in the regulatory framework, the impact analysis resulting from the introduction of the recommendations in the tax framework proposed in chapter 6 (Table 6-2) considers the possibility that these will generate higher levels of investment, which, in turn, are expected to contribute to increasing coverage, reducing prices, and stimulating adoption. This has required a disaggregated analysis in four steps (see Figure 7-3).

Figure 7-3. Impact of changes in the tax framework on sectoral development



Source: Telecom Advisory Services analysis

The quantification of estimated impacts for each tax modification comes from a series of econometric regressions detailed in Annex 13.

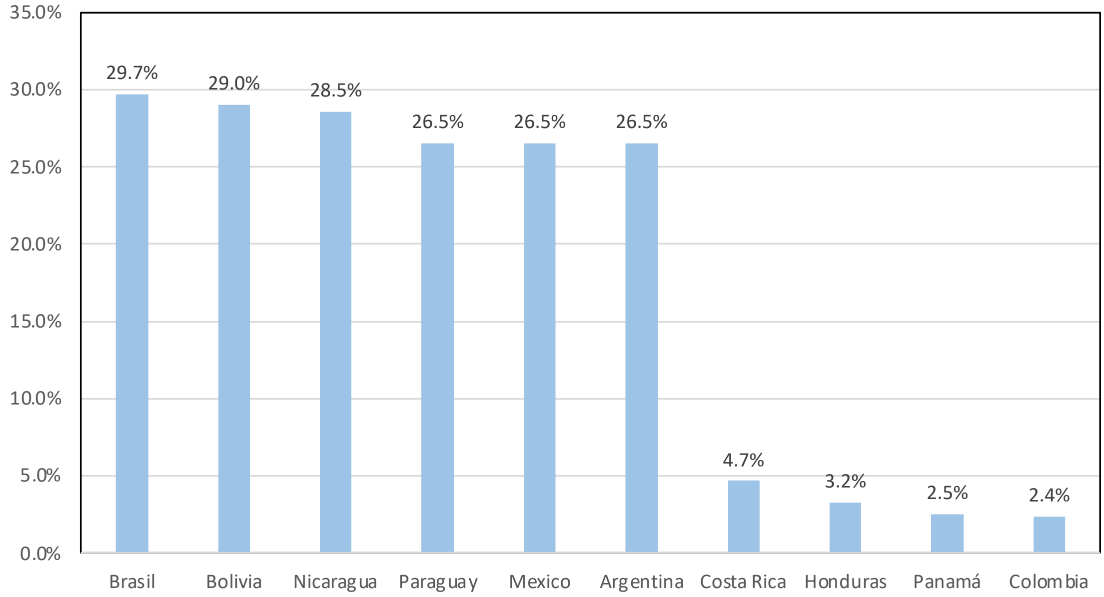
Step 1: Impact of changes in the tax framework on capital investment

Applying the impacts described in Chapter 6 (Table 6-2) to the starting point for each country (Table 7-3), we obtain how investment would evolve as a result of the tax changes in each case (Graph 7-6). For the calculation, we used the econometric estimates presented in Annex 13 (Investment model), which identify that each point of reduction in the regulatory rate (for example, from 2% to 1%) generates an increase in investment of 1.6%, while the elimination of tariffs generates an increase in investment of 14.7%.[107]

[107] This model was developed for 108 countries for the period from 2009 to 2018, the total sample being 368 observations.

As in the case of regulatory reforms, cumulative results are presented for a 5-year period, thus considering temporary investment inertia.

Graph 7-6. Cumulative increase in CAPEX as a result of tax reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

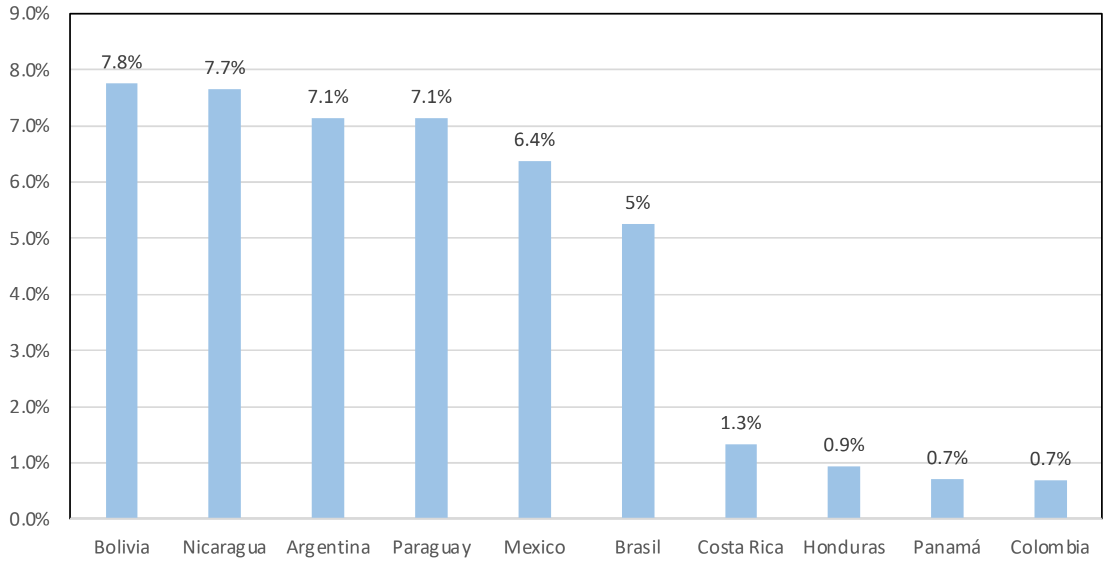
The countries that would eliminate tariffs are those that stand out in the group with the greatest investment gains. Among these, Brazil and Bolivia stand out as the countries where fiscal reforms would be the most significant. For example, in the case of Brazil, regulatory rates would be reduced by one percentage point (from 2.5% to 1.5%), while in Bolivia the reduction would be somewhat less (from 2.29% to 1.5%), which added to the elimination of tariffs on the purchase of equipment, means that these two cases have the highest levels of increase in investment. Nicaragua, although it does not formally apply a tariff on the purchase of equipment, does apply a 20% selective tax on the import of such equipment, so in practice it ends up being the same thing. On the other hand, although Paraguay generally has a favorable fiscal framework, it still imposes tariffs on equipment, which explains the significant increase in investment if this charge is eliminated.

It is important to note that, in the case of some of the countries indicated in Figure 7-6 as having a lower impact of reforms on investment, this does not necessarily imply that they have low taxes and no room for tax changes, but rather that they present favorable indicators only in those taxes that have been the object of the simulation. For example, in Honduras, the rates and fees for the use of poles are very high, but the lack of data on these types of taxes in other countries does not allow estimating an elasticity through an econometric model. Colombia and El Salvador also stand out as countries with high levels of contributions from the sector to the State, although this is not reflected in the results simulated in Figure 7-6.

Step 2: Impact of changes from increased capital investment on 4G network coverage

Increases in investment resulting from the tax reduction will be passed on in future improvements in coverage (Graph 7-7). Naturally, those cases of higher investment will be those with the greatest increase in coverage. The only exception is that of those countries that were already close to 100% coverage, which, upon reaching that level, will no longer be able to improve further (regardless of the increase in investment). The latter explains why Brazil, despite being the country where CAPEX would increase the most, is not the country where coverage would increase the most[108] .

Graph 7-7. Increase in 4G coverage as a result of tax reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

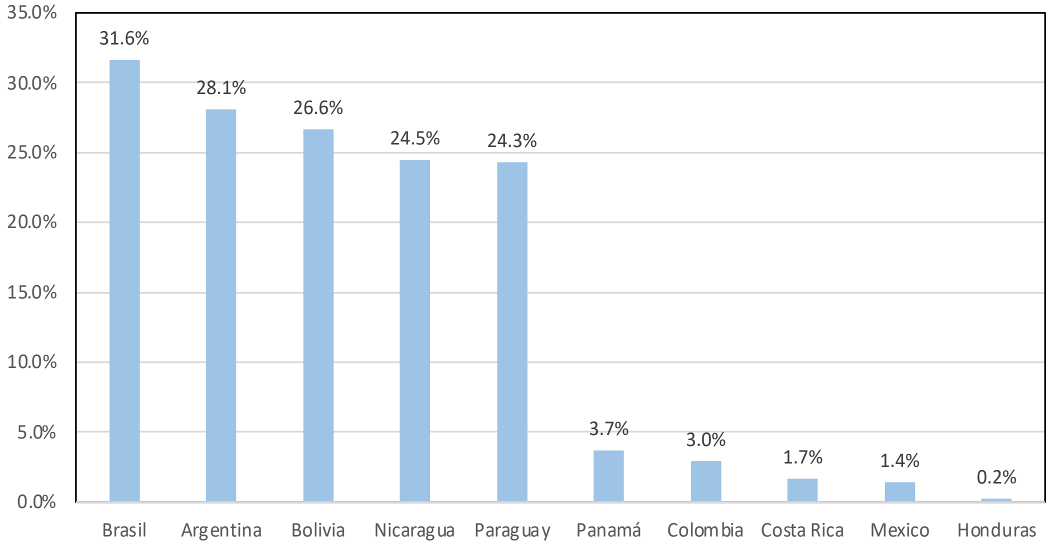
In short, Bolivia would benefit the most in terms of 4G coverage improvements, increasing it by 7.8%, followed closely by Nicaragua (7.7%), Argentina (7.1%) and Paraguay (7.1%).

Step 3: The impact of price reduction on mobile broadband penetration

The reduction in prices, together with the exemption of tariffs on smartphone imports, would explain the increases in the penetration of unique mobile broadband users (Graph 7-8). The countries where the impact on adoption is greatest are those where the elimination of tariffs would materialize.

[108] Obviously, the higher investment in these cases will be very relevant for the first 5G deployments, which could not be quantified in the model presented due to the fact that very few countries have started to deploy this technology, which prevents having a sufficient amount of data to make consistent econometric estimates.

Graph 7-8. Increase in mobile broadband unique subscriber penetration as a result of tax reforms (cumulative from t to t+5)

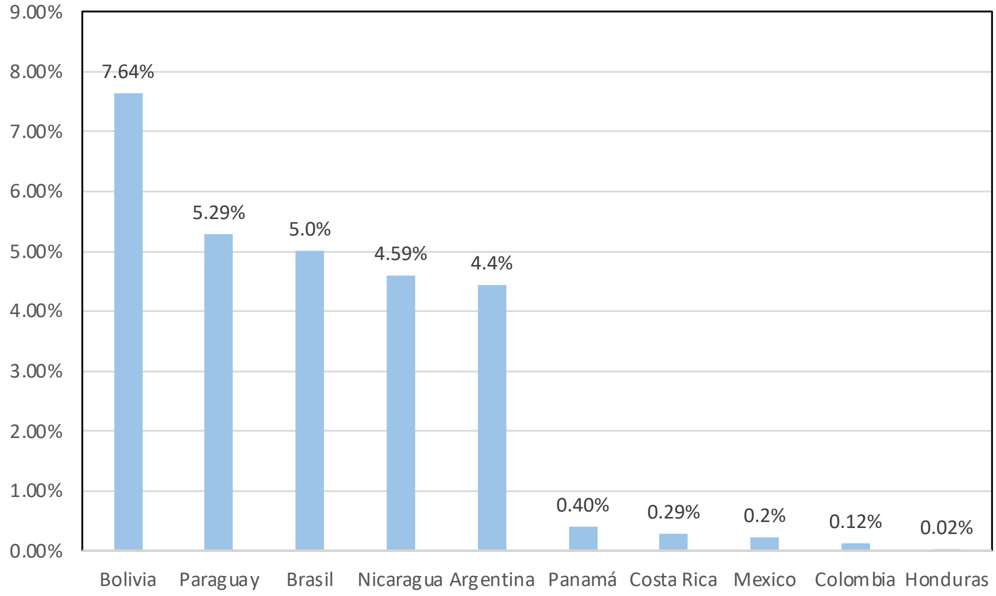


Source: Telecom Advisory Services analysis

Step 4: Impact of increasing mobile broadband penetration on GDP per capita

Finally, Graph 7-9 presents the macroeconomic effects, considering that the increase in penetration generates positive effects on GDP per capita (taking into account that a 1% increase in mobile penetration is associated with a 0.17% increase in GDP per capita in Latin America).

Graph 7-9. Increase in GDP per capita as a result of tax reforms (cumulative from t to t+5)



Source: Telecom Advisory Services analysis

7.3. Impact of reducing piracy of audiovisual content

One aspect that has not been addressed to date is to understand what the drivers of the level of impact of piracy are, and what is the impact of piracy on the local audiovisual content production industry.

Determinants of piracy

First, it is necessary to understand why some countries have a propensity to have higher levels of piracy, while others seem to have it more under control (as seen in Figure 6-1 above). However, to perform this analysis requires a panel of data that is not currently available. Therefore, in order to construct a continuous series on households affected by the piracy problem, a two-stage estimation has been carried out.

In the first stage, taking the two years for which actual data provided by the Anti-Piracy Alliance are available (2015 and 2018) and interpolating the intermediate years (2016 and 2017) based on the compound annual growth rate between the former, a panel has been constructed to explain the determinants of piracy, equation in which the price of certain pay TV services (DTH), the strength of the legal framework for the protection of intellectual property, the level of income, the penetration of debit cards and the level of regulatory bureaucracy are introduced on the right-hand side (detail of the model in Annex 14). All of these variables hypothetically represent determinants of piracy. For example, the lower the income (measured by GDP per capita), the greater the propensity to steal audiovisual signals, a tendency that may be accentuated by a weak regulatory framework for the protection of intellectual property or a high price of the service.

This model is estimated using econometric tools for the sample of countries in the region for which the Alliance Against Piracy provides data. The results are presented in the table in Annex 15.

The estimated model, which incorporates country fixed effects and a time trend, allows us to reasonably explain the determinants of piracy (R-squared of 0.98). For example, the higher the prices of pay TV services, the higher the piracy (due to reduced affordability of legal services), the stronger the intellectual property framework, the lower the piracy (given that countries have better legal instruments to combat this problem), the higher the income level, the lower the piracy (due to less difficulty in paying for legal services), the lower the penetration of debit cards, the higher the piracy (due to higher levels of informality and preference for cash), and the greater the regulatory bureaucracy, the higher the piracy.

Having determined the determinants of piracy in the econometric model in Annex 15, it is possible to calculate the impact of this problem on the development of audiovisual content in the countries of the region. This loss is in addition to those mentioned by the Alliance against Piracy and presented in Tables 6-3 and 6-4 above.

Audiovisual production is measured on the basis of a proxy variable that, although it does not contain the entire audiovisual production as in the case of television, provides an estimate of it. In the countries of the region, approximately 1,000 locally produced films are broadcast in theaters each year (Table 7-3), which is equivalent to approximately 20% of the total number of films broadcast.

Table 7-3. Annual release of locally produced films in movie theaters (2017, or latest year available)

Country	Total number of films issued in theaters	Total number of national films broadcast	Percentage of domestic films over total
Argentina	765	372	49%
Bolivia	245		
Brazil	703		32%
Chile	230		12%
Colombia	765		11%
Costa Rica	259		5%
Dominican Republic	220		14%
Ecuador			10%
Honduras	114		11%
Mexico	424		21%
Peru	356		
Venezuela			
Total	5347	1053	20%

Source: UNESCO

As a percentage of the total number of films broadcast in theaters, the countries most intensive in local production are Argentina (49%), Brazil (32%) and Mexico (21%), which is reasonable insofar as they are all large countries, presenting a sufficient scale for the development of the local audiovisual sector.

Using the coefficients in the table presented in Annex 15 and taking advantage of the fact that there are more observations of the explanatory variables than of the dependent variable, we have projected an estimate of the piracy series beyond the limits of the original sample. Based on this, we have identified those observations that are in the upper third of the distribution of the series with a binary variable called "High piracy". Introducing this binary variable in regressions allows us to identify how high levels of piracy can affect content production (see details of the model in Annex 16).

Specifically, according to the results represented in the table in Annex 17, countries that meet this condition ("High Piracy") produce fewer local movies per capita. Also, an increase in the control of piracy will accelerate the development of Pay TV (see Annex Table 18). For a country with a high level of piracy, implementing policies to reduce piracy could result in a 34.3% increase in audiovisual production (Annex Table 17 of Annex) and an 18.8% increase in pay TV penetration (Annex Table 18). This would make it possible, for example, to increase the diversity of content shown in movie theaters, from 19.7% to 24.8% of the total number of films broadcast.

In summary, it can be stated that piracy is associated with a lower production of local content, generating significant losses not only for TV providers, but also for the entire audiovisual content industry. If the countries in the region succeed in combating piracy, it is expected that the supply and diversity of local audiovisual content will increase, as well as employment levels and tax revenues for the State.

7.4. Impact of the consideration of efficient market structure

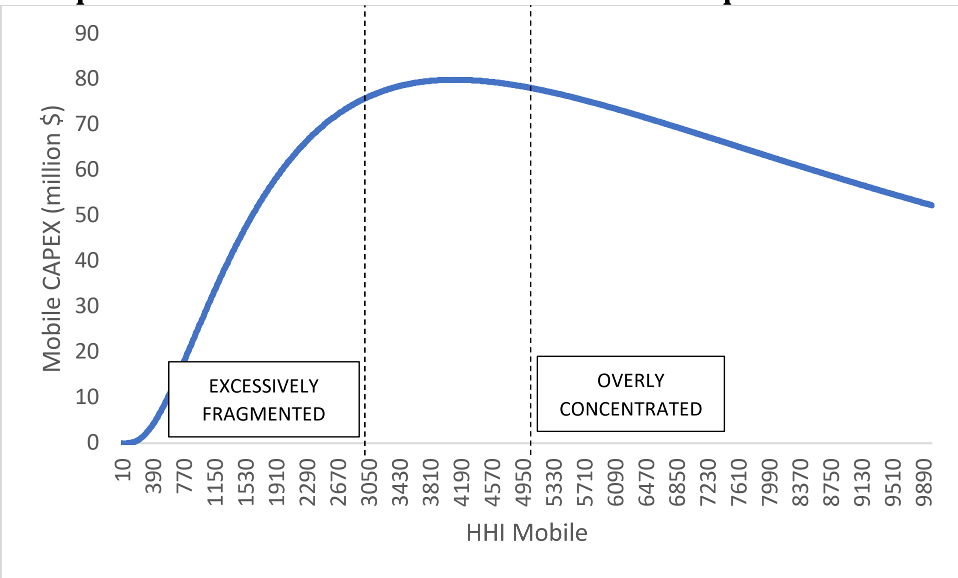
International experience, presented in chapter 6, shows that moderate concentration in telecommunications markets stimulates capital investment and acts as an incentive to reduce prices in the medium term.

In order to verify the "U-inverse" theory, we first proceed to estimate a regression in which the CAPEX of the mobile sector appears as the dependent variable, and as regressor the logarithm of the level of market concentration (Herfindahl-Hirschman Index, HHI), both in level and squared (together with other controls such as the lag of CAPEX and revenues, and a time trend). The Table in Annex 19 demonstrates that the sign and significance level of the HHI regressors are those that verify the fulfillment of the inverted-U for a global sample of countries.

Using the estimated coefficients, it is possible to simulate the investment values for each level of HHI (assuming sample mean values for the remaining explanatory variables). Given that the HHI can potentially take values up to 10000, the investment simulation for each possible level is detailed through Graph 7-11. [109]

[109] The Herfindahl-Hirschman Index (HHI) is calculated based on the sum of the market shares of each operator squared. The closer it is to the value of 10,000, the presence of a monopolistic market, while a value below 10,000 indicates a certain market fragmentation. The U.S. Horizontal Concentration Guide considers a market to be highly concentrated when the HHI is above 2,500 points. These metrics are based on competition models of advanced economies whose exclusive application does not consider one of the most important principles that should guide the supervision of competition models in emerging countries. The competition model to be defined in the telecommunications industry in emerging countries should aim to maximize the objectives of economic development and equity. Thus, effects such as increased coverage and quality of service, increased affordability for vulnerable populations, and support for the digitization of productive processes should be considered in the definition of an optimal level of the HHI index, which should be higher than that defined in advanced nations.

Graph 7-11. Simulation of investment levels for possible HHI values.



Source: Telecom Advisory Services analysis

From graph 7-11, it is evident that the U-inverted is fulfilled, as well as the existence of an optimum concentration level. The series reaches its maximum at the level of HHI=4113. When defining the optimum range, it is evident that there may be different opinions on the magnitude of the optimum range.

Linked to the level of concentration, another relevant aspect is the number of operators that maximizes the dynamic efficiencies of a market, which is usually set at three. In this regard, it is important to emphasize, however, that certain markets, due to their size, cannot accommodate more than two operators, so extrapolation of this conclusion should be approached with caution. Such is the case of several Central American or Caribbean countries, all of which are very small economies where it is possible that there is no market scale for three operators.

It is worth noting that empirical evidence from numerous markets in recent years tends to suggest a process of sector consolidation around efficient market structures (Table 7-4).

Table 7-4. Recent consolidations worldwide

Year of consolidation	Country	Number of mobile operators	Merged operators
AFRICA			
2018	Rwanda	3 a 2	Airtel and Tigo
2017	Ghana	5 a 4	Airtel and Tigo
2016	DRC	5 a 4	Orange and Tigo
2014	Congo Brazzaville	4 a 3	Airtel and Warid
2013	Uganda	6 a 5	Airtel and Warid
ASIA			
2017	India	10 a 9	Vodafone and Idea Cellular
2017	Bangladesh	6 a 5	Airtel and Axiata (Robi)
2017	Pakistan	6 a 5	Mobilink and Warid Telecom

2014	Indonesia	11 a 10[110]	Axis and Axiata
2014	Hong Kong	5 a 4	Hong Kong Tel and CSL
2013	Japan	4 a 3	Softbank and eAccess
EUROPE			
2017	Netherlands	4 a 3	Tele2 and T-Mobile
2014	Germany	4 a 3	Telefonica Deutschland and EPlus
2013	Ireland	4 a 3	O2 and 3
2012	Austria	4 a 3	Orange and Hutchinson
2010	United Kingdom	5 a 4	Orange and T-Mobile
AMERICA			
2016	Canada	4 a 3	Rogers and Mobilicity
2005	Argentina	4 a 3	Movistar and Bell South
2005	Chile	4 a 3	Movistar and Bell South

Source: Compilation of authors

It is important to note that this pattern has been observed in both developing and more advanced countries, which tend to have high ARPUs and should therefore be in a healthier financial situation. Beyond the trend towards consolidation, it should be noted that in Asia the number of operators tends to be higher, which is because these are countries with very large populations, so the market scale is more conducive to this.

7.5. Compilation of the impact of recommendations

In conclusion, the impact of the simulated regulatory and tax reforms has been consolidated in Table 7-5.

Table 7-5. Summary of impact of regulatory and fiscal reforms

	Impact of regulatory reforms (including reduction in spectrum prices)				Impact of Tax Reforms			
	Mobile CAPEX	4G Coverage	Unique mobile broadband subscribers	GDP per capita	Mobile CAPEX	4G Coverage	Unique mobile broadband subscribers	GDP per capita
Argentina	160.4 %	8.7 %	2.0 %	0.3 %	26.5%	7.1 %	28.1 %	4.44 %
Bolivia	163.7 %	25.0 %	5.6 %	1.62 %	29.0%	7.8 %	26.6 %	7.64 %
Brazil	74.9 %	5.3 %	1.2 %	0.2 %	29.7%	5.0 %	31.6 %	5.01 %
Chile	3.9 %	1.1 %	0.3 %	0.04 %				
Colombia	154.0 %	33.3 %	7.14 %	0.28 %	2.4 %	0.7 %	3.0 %	0.12 %
Costa Rica	160.4 %	12.4 %	2.8 %	0.47 %	4.7 %	1.3 %	1.7 %	0.29 %
El Salvador	77.5 %	11.1 %	2.5 %	0.27 %	0.0 %	0.0 %	0.0 %	0.00 %
Guatemala	82.8 %	13.64 %	3.1 %	0.6 %	0.0 %	0.0 %	0.0 %	0.00 %
Honduras	154.0 %	29.9 %	6.5 %	0.71 %	3.2 %	0.9 %	0.2 %	0.02 %
Mexico	0.0 %	0.0 %	0.0 %	0.0 %	26.5%	6.4 %	1.4 %	0.23 %

[110] Some Indonesian operators are regional in nature. Among the national operators, consolidation has occurred with a decrease from 5 to 4 operators.

Nicaragua	166.9 %	39.0 %	8.21 %	1.54 %	28.5%	7.7 %	24.5 %	4.59 %
Panama	170.2 %	11.1 %	2.5 %	0.27 %	2.5 %	0.7 %	3.7 %	0.40 %
Paraguay	166.9 %	14.9 %	3.4 %	0.74 %	26.5%	7.1 %	24.3 %	5.29 %

Source: Telecom Advisory Services analysis

Naturally, priorities vary by country, depending on the starting point and which reform presents the greatest opportunity for growth in the sector. In general, the reduction in spectrum prices is what generates the greatest stimulus to investment, although fiscal reforms can be very effective in increasing penetration (and therefore GDP) because they have a direct impact on various links in the chain of causalities, beyond investment. Reducing spectrum costs is an urgent measure for countries such as Argentina, Bolivia, Colombia, Costa Rica, Honduras, Nicaragua, Paraguay and Panama. Other countries, such as Argentina, Bolivia, Brazil, Nicaragua and Paraguay, are also prioritizing in-depth tax reforms.

8. CONCLUSION

Latin America has been the region of the world most affected by the economic crisis caused by the AIDS-19 pandemic. If we add to this the fact that the region's economy exhibits long-standing structural weaknesses, and that there is still a significant digital divide to close, there is no doubt that the future of prosperity in the region necessarily depends on the acceleration of digitization and the development of the digital economy.

In this context, the objectives of this study were to evaluate the status and estimate the socioeconomic impact associated with the development of fixed and mobile broadband and digitization. The estimated impacts can be summarized as follows: a 10% increase in fixed broadband penetration generates a per capita GDP growth of 1.5% in the region (economic impact), which in turn generates an important social effect, since the digital divide would be substantially reduced (unconnected households would be reduced from 43.5% to 37.8%, equivalent to 9.6 million new connected households). Similarly, a 10% increase in mobile broadband penetration generates a per capita GDP growth of 1.7%. The digital divide, measured as the percentage of unconnected people, would be reduced from 43.2% to 37.5%, which is equivalent to an increase of 36.6 million connected people. An increase in mobile broadband penetration also generates an important social effect by promoting financial inclusion. On the other hand, a 10% increase in the digitization index is associated with a 2.4% increase in the level of employment, reducing the average unemployment rate in the region from 10.5% to 8.4%, which means the creation of more than 6.5 million new jobs. Similarly, a growth in the level of digitization of 10% would allow the region to increase total factor productivity by 5.7%, which would reduce the region's productivity gap with the United States. Currently, the region has a total factor productivity equivalent to 54.4% of that of the United States. In other words, from the same number of productive factors, the countries in the region can only extract 54.4% of the production that the United States would achieve from them. With a 10% advance in the level of digitization, this productivity indicator would increase to 57.6%.

A relevant aspect is to determine how long it can take for the level of digitization to grow to reduce the gap with the most advanced countries. If we take as a reference the period 2010-2020, the level of digitization in Latin America has been growing at an average annual rate of 3.9%, so that an increase of 10% as simulated above would take at least 3 years. However, the region must aspire to more ambitious goals, for which it will have to undertake profound changes such as those discussed in this document. The pace of digitization growth in the region is insufficient, especially if we compare it with that of other emerging economies during the same period, such as Indonesia (7.2%), Vietnam (7.5%), Bangladesh (8.2%), or Zambia (8.3%). At the current rate, it would take Latin America until 2030 to reach the current OECD level of digitization, while if the region were to grow at a similar rate to the countries mentioned above, this time span would be shortened to 2026.

On the other hand, developing effective measures to combat piracy will stimulate the production of local content, given that the analyses carried out indicate that countries with lower levels of piracy produce 34.3% more content. This would make it possible, for example, to increase the diversity of content shown in movie theaters, from 19.7% to 24.8% of the total number of films shown. The successful fight against piracy will also mitigate the loss of income for TV providers (estimated at 4.8 billion dollars per year), programmers (estimated at 1.8 billion) and the more than 48,500 jobs lost due to this problem. Likewise, combating piracy will allow governments to reduce the associated tax evasion, estimated at around 1.1 billion dollars per year.

Given the socioeconomic relevance of the sector for Latin America, the region needs to reformulate its regulatory and fiscal frameworks in order to accelerate the deployment of telecommunications networks and the development of the digital economy. Accelerating investment is a priority, given the significant growth in traffic levels in the region.

Considering the current lag in investment in the region, there is ample potential to increase it through regulatory and fiscal reforms. To this end, the proposed reforms simulated in this study have made it possible to quantify the magnitude of such impacts in terms of investment, coverage, penetration, and GDP per capita. Naturally, priorities vary by country, depending on the starting point and which reform presents the greatest opportunity for growth in the sector. In general, reduction in spectrum prices is what generates the greatest stimulus to investment, although tax reforms can be very effective in increasing penetration (and therefore GDP). Reducing spectrum costs is an urgent measure for countries such as Argentina, Bolivia, Colombia, Costa Rica, Honduras, Nicaragua, Paraguay, and Panama. Other countries, such as Argentina, Bolivia, Brazil, Nicaragua, and Paraguay, are also prioritizing in-depth tax reforms.

In closing, it is important to emphasize that Latin America is facing a great opportunity, and that this opportunity necessarily involves digitization. However, the current pace of progress seems to be insufficient for the region to achieve the necessary levels of prosperity. Therefore, ambitious and decisive public policies are needed to enable countries to make a substantial leap in the levels of investment and digital development.

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ANNEXES

Annex 1. Percentage change in the volume of exports by country.

Country	Export volume of goods			Export volume of goods and services		
	2019		2021	2019		2021
Argentina	12.402	-13.167	6.802	12.155	-13.124	6.751
Bolivia	2.509	-18.72	5.532	2.509	-18.72	5.532
Brazil	-1.929	0.158	8.445	-1.579	-1.249	8.963
Chile	-2.382	3.014	0.081	-2.583	-1.065	-0.173
Colombia	0.893	-9.761	0.494	3.071	-9.761	0.494
Costa Rica	3.133	0.788	27.852	3.089	-9.481	11.9
Dominican Republic	2.023	-13.527	1.883	-0.388	-33.3	19.609
Ecuador	8.013	5.082	-1.617	7.487	0.236	-0.832
El Salvador	1.716	-13.451	15.159	6.331	-21.545	20.893
Guatemala	0.08	-4.449		0.08	-4.449	
Honduras	3.556	-11.84	-0.074	3.556	-11.84	-0.074
Mexico	1.213	-4.73	8.708	1.48	-7.299	7.769
Nicaragua	0.227	-2.639	5.309	-1.068	-9.378	5.001
Panama	-1.976	-15.336	11.156	-0.299	-26.768	15.147
Paraguay	-4.48	-9.693	15.769	-4.139	-9.368	15.062
Peru	1.78	-13.277	10.301	1.78	-13.277	10.301
Uruguay	-0.218	-14.891	7.123	-3.667	-21.693	1.892
Venezuela	-33.308	-48.916	-49.602	-30.163	-50.461	-44.491

Source: IMF

Annex 2. Percentage change in the volume of imports by country.

Country	Import volume of goods			Import volume of goods and services		
	2019		2021	2019		2021
Argentina	-20.846	-10.588	23.097	-21.107	-10.722	23.228
Bolivia	-0.39	-23.801	18.168	-0.39	-23.801	18.168
Brazil	6.361	-2.464	9.225	5.288	-7.699	10.65
Chile	-2.485	-10.254	32.717	-2.38	-12.835	30.899
Colombia	1.786	-15.696	6.207	7.344	-15.696	6.207
Costa Rica	0.051	-7.895	8.935	0.051	-7.895	8.935
Dominican Republic	3.933	-9.492	7.958	4.934	-11.822	10.08
Ecuador	0.366	-11.335	12.207	0.772	-14.151	13.521
El Salvador	3.118	-6.211	17.6	0.923	-7.794	17.934
Guatemala	4.911	-4.603	9.5	4.911	-4.603	9.5
Honduras	-1.481	-4.941	4.159	-1.481	-4.941	4.159
Mexico	-0.748	-13.384	17.649	-0.726	-14.557	17.303
Nicaragua	-5.951	3.723	5	-6.617	-0.376	5.127
Panama	-9.888	-28.416	35.115	-8.091	-29.359	34.157
Paraguay	-5.01	-17.975	-2.011	-4.511	-15.213	-2.493
Peru	-0.096	-11.055	12.37	-0.096	-11.055	12.37
Uruguay	-6.03	-3.761	10.153	-3.424	-11.283	10.811

Venezuela	-33.144	-15.902	-8.952	-32.647	-20.57	-10.057

Source: IMF

Annex 3. Structural model for estimating the economic impact of broadband

Aggregate production function	GDP per capita$_{it}$ = a$_1$ (Capital$_{it}$) + a$_2$ (Education$_{it}$)+a$_3$ (Broadband Penetration$_{it}$)+ e$_{it}$ (1)
Demand function	Broadband Penetration$_{it}$ = b$_1$ (Rural Population)$_{it}$ + b$_2$ (Price)$_{it}$ +b$_3$ (GDP per capita)$_{it}$ +b$_4$ (HHI)$_{it}$ +e$_{it}$ (2)
Offer function	Broadband Revenue$_{it}$ =c$_1$ (Price)$_{it}$ +c$_2$ (GDP per capita)$_{it}$ + c$_3$ (HHI)$_{it}$ + e$_{it}$ (3)
Sectoral production function	Δ Broadband Penetration$_{it}$ = d$_1$ (Broadband Revenue$_{it}$) + ε$_{4it}$ (4)

Annex 4. Latin America: Fixed Broadband Economic Impact Model in Latin America

Log (GDP per capita)	
Log (Gross Fixed Capital Formation)	0.254***
	[0.019]
Log (Education)	0.098***
	[0.031]
Log (Fixed broadband penetration)	0.147***
	[0.042]
Log(Fixed broadband penetration)	
Log (Fixed telephony penetration)	0.290***
	[0.051]
Log (Rural population)	-0.016
	[0.023]
Log (GDP per capita)	0.801***
	[0.050]
Log (Fixed broadband price)	-0.366***
	[0.022]
Log (Herfindahl Index for fixed broadband)	-0.008
	[0.029]
Log (Fixed broadband revenues)	
Log (GDP per capita)	0.747***
	[0.131]
Log (Fixed broadband price)	0.753***
	[0.070]
Log (Herfindahl Index for fixed broadband)	-1.213***
	[0.090]
Broadband adoption growth	
Log (Fixed broadband revenues)	0.136
	[0.128]
Remarks	868
Fixed effects by country	Yes
Fixed effects per year and quarter	Yes
R-squared of the first model	0.972

*Note: *p<10%, **p<5%, ***p<1%. Standard errors in parentheses*
Source: Telecom Advisory Services analysis

Annex 5. Latin America: Model of the Economic Impact of Mobile Broadband in Latin America

Log (GDP per capita)

Log (Gross Fixed Capital Formation)	0.145***
	[0.034]
Log (Education)	0.087***
	[0.030]
Log (Mobile broadband penetration)	0.170***
	[0.044]
Log (Mobile broadband penetration)	
Log (Mobile telephony penetration)	-0.581*
	[0.301]
Log (Rural Population)	0.114
	[0.092]
Log (GDP per capita)	1.198***
	[0.406]
Log (Mobile broadband price)	-0.157***
	[0.036]
Log (Herfindahl Index for Mobile Broadband)	-0.006
	[0.086]
Log (Mobile broadband revenues)	
Log (GDP per capita)	1.234***
	[0.392]
Log (Mobile broadband price)	0.791***
	[0.067]
Log (Mobile Broadband Herfindahl Index)	-0.029
	[0.153]
Growth in mobile broadband adoption	
Log (Mobile broadband revenues)	0.015**
	[0.006]
Remarks	639
Fixed effects by country	Yes
Fixed effects per year and quarter	Yes
R-squared of the first model	0.958

*Note: *p<10%, **p<5%, ***p<1%. Standard errors in parentheses*
Source: Telecom Advisory Services analysis

Annex 6. Model to estimate the impact of digitization on productivity.

$$\text{Log (Productivity}_{it}\text{)} = a_1 \text{ Log (Capital per worker}_{it}\text{)} + a_2 \text{ Log (Human Capital}_{it}\text{)} + a_3 \text{ Log (Digitization}_{it}\text{)} + e_{it}$$

Annex 7. Productivity model estimation

Dependent variable: Log (Productivity)	
Log (Capital per worker)	0.142
	[0.103]
Log (Human Capital)	-0.118
	[0.282]
Log (Digitization)	0.573**
	[0.266]
Fixed Effects by country	YES
Fixed Effects per year	YES
R2	0.413
Remarks	

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services

Annex 8. Model to estimate the impact of digitization on employment.

$$\text{Log}(\text{Employment}_{it}) = a_1 \text{Log}(\text{Capital}_{it}) + a_2 \text{Log}(\text{Human Capital}_{it}) + a_3 \text{Log}(\text{Digitization}_{it}) + e_{it}$$

Annex 9. Estimated Employment Model

Dependent variable: Log (Employment)	
Log (Capital)	0.082**
	[0.036]
Log (Human Capital)	0.265
	[0.292]
Log (Digitization	0.244***
	[0.057]
Fixed Effects by country	YES
Fixed Effects per year	YES
R2	0.920
Remarks	

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services analysis

Annex 10. Model for estimating the impact of mobile broadband on financial inclusion

$$\text{Log}(\text{Financial Inclusion}_{it}) = a_1 \text{Log}(\text{Human Capital}_{it}) + a_2 \text{Log}(\text{GDP pc}_{it}) + a_3 \text{Log}(\text{Rural population}_{it}) + a_4 \text{Log}(\text{Mobile broadband}_{it}) + e_{it}$$

Annex 11. Estimation of the Financial Inclusion Model

Dependent variable: Log (Financial Inclusion)	
Log (Human Capital)	3.974**
	[1.653]
Log (GDP per capita)	0.303
	[0.289]
Log (Rural Population)	0.559
	[0.945]
Log (Mobile broadband penetration)	0.232*
	[0.122]
Fixed Effects by country	YES
R2	0.796
Remarks	

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services analysis

Impact of regulatory quality on telecommunication investment

Dependent variable: Log (CAPEX)	**[I]**	**[II]**	**[III]**	**[IV]**	**[V]**	**[VI]**
Log (CAPEX) $_{t-1}$	0.596***	0.593***	0.359***	0.313**	0.352*	0.336*
	[0.088]	[0.089]	[0.122]	[0.142]	[0.181]	[0.180]
Log (Revenue) $_{t-1}$	0.342***	0.346***	0.575***	0.667***	0.551***	0.583***
	[0.091]	[0.095]	[0.116]	[0.158]	[0.176]	[0.179]
Regulatory Tracker	0.005***	0.005***			0.015*	0.017**
	[0.002]	[0.002]			[0.008]	[0.007]
Regulatory Tracker $_{t-1}$			0.003*	0.010**		
			[0.002]	[0.005]		
Log(GDP per capita) $_{t-1}$		-0.022		-0.457		-0.013
		[0.042]		[0.310]		[0.187]
Urban population		0.001		0.019		-0.004
		[0.002]		[0.014]		[0.008]
Year fixed effects	YES	YES	YES	YES	YES	YES
R-squared	0.896	0.896				
Arellano-Bond test for AR(1) in first differences			-1.57	-1.55	-2.02**	-2.00**
Arellano-Bond test for AR(2) in first differences			0.92	0.92	-0.76	-0.78
Hansen test of overid. Restrictions			125.57*	120.75	110.79	110.43
Treatment for regulatory variable	Exogenous	Exogenous	Exogenous (lagged)	Exogenous (lagged)	Endogenous (using only external instruments)	Endogenous (using only external instruments)
Observations	1142	1138	1066	1063	875	875
Estimation Method	OLS	OLS	GMM Arellano-Bond	GMM Arellano-Bond	GMM Arellano-Bond	GMM Arellano-Bond

*Notes: *p<10%, **p<5%, ***p<1%. Robust standard errors in brackets. Estimates in columns [I] and [II] include region fixed effects.*

Annex 13. Estimation of models used in simulations

Investment		Coverage		Prices		Adoption	
Variable Dep.: Log (CAPEX)		Variable Dep.: Log (4G coverage)		Variable Dep.: Log (MBB price)		Variable Dep.: Log (MBB penetration)	
Log (CAPEX) $_{t-1}$	0.667***	Log (CAPEX) $_{t-2}$	0.225**	Log (4G coverage)	-0.447**	Log (MBB price)	-0.503***
	[0.066]		[0.091]		[0.189]		[0.151]
Log (Revenue) $_{t-1}$	0.343***	Log (Cellular coverage) $_{t-1}$	2.064**	SMP	-0.189***	VAT	0.000
	[0.067		[0.943]		[0.070]		[0.012]
Log (HHI)	0.073	Log (Cellular coverage) $_{t-2}$	0.061	Mobile taxation	0.014***	Duty cell dummy	-0.224*
	[0.075]		[0.764]		[0.005]		[0.122]
Urban population	0.001	Log (Cellular coverage) $_{t-3}$	2.193***	Duty cell dummy	-0.034	Log (Population age)	0.165
	[0.001]		[0.584]		[0.200]		[0.363]
Log (GDPpc) $_{t-1}$	-0.080**	Urban population	0.139***			Log (GDPpc) $_{t-1}$	0.252*
	[0.032]		[0.048]				[0.130]
Regulatory fee	-0.016*						
	[0.010]						
Profit tax	-0.009**						
	[0.005]						
Duty	-0.147***						
	[0.042]						
VAT	0.008						
	[0.006]						
Labor tax	-0.003						
	[0.003]						
Other taxes	-0.000						
	[0.002]						
Year fixed effects	YES	Country fixed effects	YES	Country fixed effects	YES	Country fixed effects	YES
Arellano-Bond test forAR (1) in first differences	-3.63***	Year fixed effects	YES	Year fixed effects	YES	Year fixed effects	YES
Arellano-Bond test for AR(2) in first differences	-1.40	Underid. Test	68.851***	Underid. Test	19.547***	Underid. Test	12.925***
Hansen test of overid. restrictions	31.71	Hansen test of overid. restrictions	0.612	Hansen test of overid. restrictions	0.538	Hansen test of overid. restrictions	2.306
Observations	368	Observations	487	Observation s	437	Observations	524
Estimation method	GMM Arellano-Bond	Estimation method	IV	Estimation method	IV	Estimation method	IV

*Notes: *p<10%, **p<5%, ***p<1%. Robust standard errors in brackets.*

Annex 14. Model for estimating the determinants of piracy

Log (Pirated TV connections per household$_{it}$) = a_1 Log (DTH price$_{it}$) +a_2 Log (Intellectual property protection$_{it}$) +a_3 Log (GDP pc$_{it}$) +a_4 (Debit card$_{it}$) +a_5 Log (Regulatory burden$_{it}$) + e $_{it}$

Annex 15. Latin America: Determinants of Piracy

Dependent variable: Log (Pirated TV connections/household).	
Log (DTH Price)	0.0444***
	[0.0162]
Log (Intellectual Property Protection)	-0.0272*
	[0.0148]
Log (GDP pc)	-0.0251***
	[0.0084]
Debit card (% population)	-0.2370***
	[0.0400]
Log (Regulatory burden)	0.0003***
	[0.0001]
Fixed Effects by country	YES
Time trend	YES
R-squared	0.983
Remarks	

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services analysis

Annex 16. Model to estimate the impact of piracy on content production

$$Log\ (Local\ Movies\ per\ capita_{it}) = a_1\ (High\ Piracy_{it}) + a_2\ Log\ (Pay\ TV\ Penetration_{it}) + a_3\ Log(GDP\ pc_{it}) + a_4\ (Population_{it}) + e_{it}$$

Annex 17. Latin America: Impact of piracy in content production

Dependent variable: Log (Local films per capita)	
High Piracy	-0.3430*
	[0.1944]
Log (Pay TV penetration)	0.8512**
	[0.3815]
Log (GDP pc)	0.1541
	[0.2539]
Population	0.0411
	[0.0260]
Fixed Effects by country	YES
R-squared	0.797
Remarks	86

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services

Annex 18. Latin America: Impact of piracy on Pay TV development

Dependent variable: Log (Pay TV penetration)	
High Piracy	-0.1879***
	[0.0517]
Pay TV price (growth rate)	-0.0684**
	[0.3997]
Log (GDP pc)	0.3399***
	[0.1006]
Human capital	1.0538***
	[0.3066]
Fixed Effects by country	YES
R-squared	0.863
Remarks	

*Note: *p<10%, **p<5%, ***p<1%. Robust standard errors in parentheses.*
Source: Telecom Advisory Services

Annex 19. Empirical estimation to verify compliance with inverted U

Dep. var. = Log (Mobile CAPEX)	
Log (Mobile CAPEX) (t-1)	0.808***
	[0.066]
Log (Mobile Revenue) (t-1)	0.153**
	[0.062]
Log(HHI mobile)	8.938**
	[4.419]
Log(HHI mobile) - squared	-0.537**
	[0.268]
Arellano-Bond test AR(1) first differences	-5.60***
Arellano-Bond test AR(2) first differences	-1.07
Over-identification test (Hansen J-test)	122.89
Time-trend	YES
Observations	754

*Notes: *p<10%, **p<5%, ***p<1%. Robust standard errors in brackets.*