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in Latin America and the Caribbean

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The Evolution of Mobile Telecommunications in Latin America and the Caribbean

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In this study, we document and compare the progression of mobile phone penetration for twenty-six Latin American and Caribbean countries and the capital expenditures associated to this expansion. Using a detailed dataset at the firm level we study coverage expansion, investments, technology deployment and service quality trends. We explore the cycle of emergence to obsolescence on each one of the four mobile technology generations and we show that it was under the second-generation technology that most of the expansion of the access to mobile phone took place. Despite the consolidation of market penetration at levels above 80% of the population on the richest countries, there are significant access gaps in some countries and quality gaps in terms of 4G coverage and connection speed across all the region. These insights are paramount as a first step to a deeper evaluation of the dynamics of this industry in Latin America.

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1 Introduction

The telecommunication industry is at the core of development. It fosters economic growth and it helps to improve people's lives. Telecommunication services play a key role in achieving each one of the 17 UN Sustainable Development Goals, from promoting access to health services to helping improving education outcomes. The advance of telecommunication technologies is also at the core of achieving sustainable infrastructure, cities, and communities. It is not possible to think of smart meter infrastructure devices, green smart buildings or citywide catastrophe coordination centers without modern telecommunication services. These services are also critically important to foster and improve innovation, create new products and services, and tackle climate change.

Telecommunications, and specifically broadband availability, create jobs and business opportunities, increase firm productivity, and connect people, regions, and markets in ways that were unimaginable a few years ago. Quality telecommunication services have the potential to boost opportunities for the most vulnerable populations, by decreasing the digital gap.

Broadband availability positively affects employment, firm productivity and economic growth. On employment, broadband availability added 1.0-1.8% to the growth rate of local employment and 0.5-1.2% to the growth rate of the number of business establishments (Gillet et. al, 2006) and these effects are larger in rural and isolated areas (Atasoy, 2013). Additionally, the increased use of broadband services is associated with higher payroll (Van Gaasbeck, 2008).¹

Regarding firm productivity, broadband adoption boosts firm productivity by 7–10%. These effects are consistent across urban and rural locations and across high versus low-knowledge intensive sectors (Grimes et. al, 2012). However, in order for broadband adoption to have a full impact on productivity, it is necessary that a suitable environment be present. In the first place, the effect on productivity is not instantaneous. It takes time. There is compelling evidence that the returns of IT are generally more pronounced over the long term (Devaraj and Kohli 2003, Brynjolfsson and Hitt 2003, Tambe and Hitt 2012). This is because firms do not simply plug in IT and enjoy its effects immediately, they have to undertake a challenging transition from their existing business processes and have to make complementary investments (Brynjolfsson et al. 2002, Brynjolfsson and Hitt 2003). Secondly, effects are not always equal across firm size. Bigger firms may be better equipped to take full advantage of broadband services. SMEs are found to benefit from adopting selected advanced broadband applications depending on complementary factors such as: (i) industry of operations

¹These studies refer to the early adoption phase in the US, from 1987 to 2004, and use administrative data and panel data estimation to find correlations among these variables. Atasoy's study, however uses IV estimation to establish a causal relationship.

(services vs. manufacturing); (ii) the relevance of the specific broadband software applications for SMEs' industry of operation; and (iii) the undertaking of complementary strategic and organizational changes. When these factors are present, productivity gains range between 20% and 70% (Colombo et. al, 2013).²

Finally, broadband adoption has a positive impact on economic growth. A 10 percentage point increase in broadband penetration raised annual per capita growth by 0.3 to 1.5 percentage points (Czernich et. al, 2011). Effects are closer to the upper bound when a critical mass of infrastructure is present (Koutrompis, 2009).³ For LAC, Garcia Zaballos and Lopez-Rivas (2012) found that a 10% broadband expansion is associated with a 3.2% increase in GDP, although they could not established a causal relationship.

Anecdotal evidence also highlights how broadband services can improve people's lives. In Mali, residents of Timbuktu can call relatives living in the capital city of Bamako or relatives in France. In Ghana, farmers in Tamale are able to send a text message to learn corn and tomato prices in Accra, over 400 kilometers away. In Niger, day laborers are able to call acquaintances in Benin to find out about job opportunities without making the USD40 trip. In Malawi, those affected by HIV and AIDS can receive text messages daily, reminding them to take their medicines on schedule (Aker and Mbiti, 2010).

However, the mobile broadband revolution presents a challenge. As with every technological revolution, there are winners and losers. There are dynamic sectors that take full advantage of the new possibilities and there are traditional sectors that are relegated. There are skills whose demand increases, benefiting certain type of workers, and skills, whose demand falls, hurting the workers that cannot keep up with the changes.

For these reasons, it is critically important that the digital dividend reaches all, and specifically that it reaches the most vulnerable sectors of the population. Without this, the gap between the digital haves and the digital have-nots will increase up to the point where the costs and negative effects of the gap outweighs the gains from the technical advances. This is why it is important to understand investment in deployment of new technologies, access and adoption trends.

Since the advent of mobile phones in the late 1990's, the telecommunication's industry has already experienced four major leaps in technology. Each new generation of mobile phone technology (i.e. 2G, 3G, 4G) is associated with a new wave of investments by telecommunication's companies. From the late 1990's to 2017, four new generations required together investments equivalent to 0.15%

²These studies use model structural estimation and they cover North America, New Zealand and Europe.

³These studies use panel instrumental variable estimation to find a causal relationship between broadband adoption and GDP growth, using a panel from many countries around the world covering the period 1996-2007.

of the world GDP. While in developed countries the ability of companies to access financial markets to finance such expansions is well-known, in Latin American countries the source of funds to finance the technological progression of this industry is left to be explored.

In order to fully understand the development of the telecommunication industry is necessary to consider two dimensions: first, infrastructure deployment and adoption, and second, skill development and content creation. Both dimensions are complementary to each other and equally important. Of course, infrastructure (physical networks, connected devices) is the basic input for industry advancement, but deployment is not enough by itself. Equally important is the adoption rate. If the infrastructure is not used, if users do not adopt the technology, investments make no sense. The question is then, how to incentivize adoption, once the infrastructure is in place? Here, skills and content play a key role. Consumers will adopt (buy) the services if they find benefits in doing so, and they will, if they find interesting content they can consume. Interestingly, consumers prefer local content, content that is in a language they understand and that caters to their interest and reflects their idiosyncrasies. So, to encourage adoption, a critical mass of local content needs to be available to consumers, and local content comes from local developers with the necessary skills. It is then also very important to have available skilled workers and local firms to create local content.

In the present work, we study the first dimension. We document and compare the progression of technology deployment and consumer adoption, studying mobile phone penetration trends in each of the 26 Latin American and Caribbean countries that are borrowing members of the Inter-American Development Bank Group (IDBG) between 2000 and 2017. Access to mobile phone increased from less than 10% of the population on the year of 2000 to more than 70% in 2017. We also study the necessary investment (capital expenditures) associated to this expansion. Despite the consolidation of market penetration at levels above 80% of the population on the richest Latin American countries, the advent of the third and fourth generations increased investments levels from less than 10% to more than 20% of the industry's revenue. On another basis, the investment in capital as a share of GDP increased from than 0.05% on the year 2000 to almost 0.1% on 2017.

The cycle of emergence to obsolescence on each one of the four mobile phone generations is also explored. We show that it was under the second-generation technology that most of the expansion of the access to mobile phone took place. While the third generation technology had a cycle that lasted 4 years before starting to lose customers to the fourth generation, the second generation had a 8-year cycle. This is evidence that technology progress and adoption is moving faster over time.

Moreover, we discuss the market structure behind the expansion of the access to mobile phones. As it was mostly carried by the private sector, the telecommunication's industry is unique among in-

infrastructure sectors in Latin America. Historically, infrastructure sectors have been under the control of the government during periods of heavy investments. However, the private sector has a predominant role in the telecommunication industry in Latin America, and while monopolies are not present, the sector should not be considered perfectly competitive as there are a few players in all markets.

These insights are paramount as a first step to a deeper evaluation of the dynamics of this industry in LAC. Particularly, if we are interested in a future investigation about the financing of the telecommunication industry it is important to analyze the trends in the access to mobile phones, in the number of connections by technology generation, the overall investment amounts, the industry's market structure and its regulatory issues. This work is the first study that analyzes the trends of mobile penetration and technology adoption over a long period of time for the majority of LAC countries. Using a novel, detailed dataset from GSMA Intelligence, we are able to identify and compare market penetration rates, investment trends and technological adoption over 17 years, from a single, homogeneous data source that allows comparisons across countries and periods. This work produces one of the most complete descriptions of the mobile telecommunication industry for LAC. This work is related to other sector studies such as ECLAC's *El estado de la banda ancha en America Latina y el Caribe* (2016, 2018) and academic papers, i.e. Barrantes and Galperin (2008). Our study, however, covers more countries and years than the cited works, offering a more detailed picture of industry trends for the whole region over a longer period of time.

The study proceeds as follows. Section 2 describes the dataset employed in the empirical analyses. Section 3 provides the evaluation of the trends in access to mobile phone. Section 4 presents the evolution of connections by technology generation. Section 5 analyzes the evolution of investments made by the telecommunication industry. Section 6 discusses the relationship between service quality and development impact. Section 7 describes the market structure and the regulatory framework of the mobile telecommunication industry in Latin America and the Caribbean. Finally, Section 8 concludes.

2 Data

We use a novel dataset from GSMA Intelligence.⁴ The dataset contains quarterly information, from 2000 Q1 to 2017 Q3. The period is long enough to study medium to long run trends in the telecommunication industry. Unfortunately, it does not go back to the early 1990's when most of the pri-

⁴All telecommunication data, graphics and data analyses in this document are based on GSMA's proprietary data, (c) GSMA Intelligence, 2016, unless otherwise noted.

vatization of the telecommunication companies and first deployment of mobile voice services took place. However, it spans over a long enough period to include many industry-key events. From mobile internet introduction and deployment with the 1G/2G technologies in the early 2000's to the current 4G revolution around 2010. It also covers a period where many mergers and acquisitions took place, and where new firms entered Latin American markets.

The dataset contains information regarding four important topics: technology deployment dates, consumer adoption rates, identity of each active operator (and some which have exited the market) and investment. More specifically, it allow us to observe dates of deployment of different technologies, from 1G to 4G. It also contains detailed information on number of subscribers and phone connections per country. This type of information is extremely useful to analyze adoption rates and trends. That is, we can observe not only technology introductory dates, but also the speed at which consumers in each country actually adopt these technologies and market penetration rates. Finally, the dataset has information on investment, defined as the CAPEX made by firms in each country.

GSMA obtains information from different sources, then standardize it so it is comparable across countries and years. GSMA collects some variables directly from regulatory authorities, such as information that operators are legally required to submit to the regulator and which the regulator made publicly available. Among these, number of subscribers (or connections) and technology introductory dates in most countries. Other variables are collected from companies public reports, such as the ones that Stock Exchanges require listed companies to submit. Among these variables, financial information such as aggregated CAPEX. Other pieces of information are collected directly from the operators, such as investments. While GSMA makes an effort to have accurate data, the information collected from the operators is self-reported.

We combine the GSMA data information with other economic and demographic data, such as GDP and country populations from the World Bank's World Development Indicators. This type of information is originally reported on an annual basis, and standard interpolation techniques are used to fill in quarterly data. This data allow us to better understand how evolution of the mobile telecommunication expansion and adoption rates might be correlated with social and economic characteristics of LAC countries. We are going to concentrate the analysis in the 26 LAC countries that are IDB-borrowing members.

3 Market Penetration

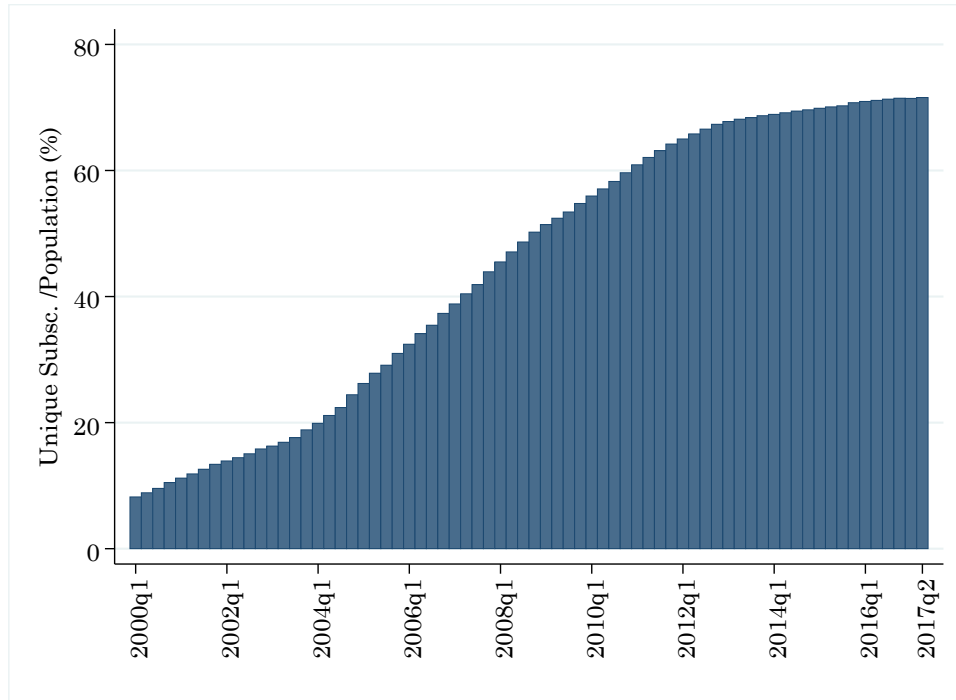
We use market penetration, defined as the number of unique subscribers over the total population, as our main measure to assess the access to this technology from 2000 to 2017. It is important to distinguish between number of phones, or connections, and unique subscribers. Unique subscribers refer to the number of people that have a access to a service or technology. However, unique subscribers may have more than one phone. Then, it is possible that there are more connections than unique subscribers, if some subscribers have more than one line. In this way, using connections may overestimate the actual penetration rate. In order to accurately determine this rate rate, we use unique subscribers, or individuals. Individuals with more than one mobile phone count as one unique subscriber for the purposes of determining penetration and adoption rates.

Figure 1 shows that for the year of 2000, less than 10% of the population had a mobile phone. The high cost of the mobile devices at that time relative to the average income can be attributed as the main reason for the low market penetration. According to the U.S. Bureau of Labor Statistics, prices for wireless telephone services were 37.04% lower in 2017 versus 2000 (U.S. Bureau of Labor Statistics, Consumer Price Index for wireless telephone service). While there is no comprehensive, standardized data for LAC, evidence from different studies shows the same trend. The monthly cost of prepaid low-volume mobile basket as a percentage of the minimum monthly wage in 2007 (year of introduction of the iPhone) ranged from 5% in Argentina and Chile, to about 10% in Colombia and Uruguay to more than 15% in Brazil and Mexico (Barrantes and Galperin, 2008). The cost of a similar service basket in 2016⁵ is less than 3% in Argentina and Chile (i.e. roughly 40% less with respect to 2007), less than 4% in Brazil, Colombia, and Uruguay, and about 7% in Mexico (60% less for these countries and even lower for Brazil).

While the access to mobile phones grew at a rate of 2.5 percentage points (p.p.) on the first four years of the decade of 2000, on 2004 the telecommunication industry experienced an inflection point. Growth accelerated to almost 6 p.p. per year and kept at this high pace until late 2012, when almost 70% of the population already had a mobile device. From 2012 to 2017, growth decelerated to less than 2p.p. per year, indicating that the mobile market may be reaching a saturation point (measured as access to mobile phone).

⁵Minimum cost for a prepaid mobile broadband data package. This basket is not directly comparable to the one used by Barrantes and Galperin (2008) since it includes more services, but it is useful to make our case: first, because it includes more services at a lower cost, which reinforces our case, and second, because both studies use a standard, basic package at the time they were written. In this fast evolving industry, to compare service cost across years it is reasonable to compare the same *category* of services, in this case basic packages, even though the actual bundles do not include the exact same items: the basic package in 2007 is obsolete in 2016.

Figure 1. Market Penetration

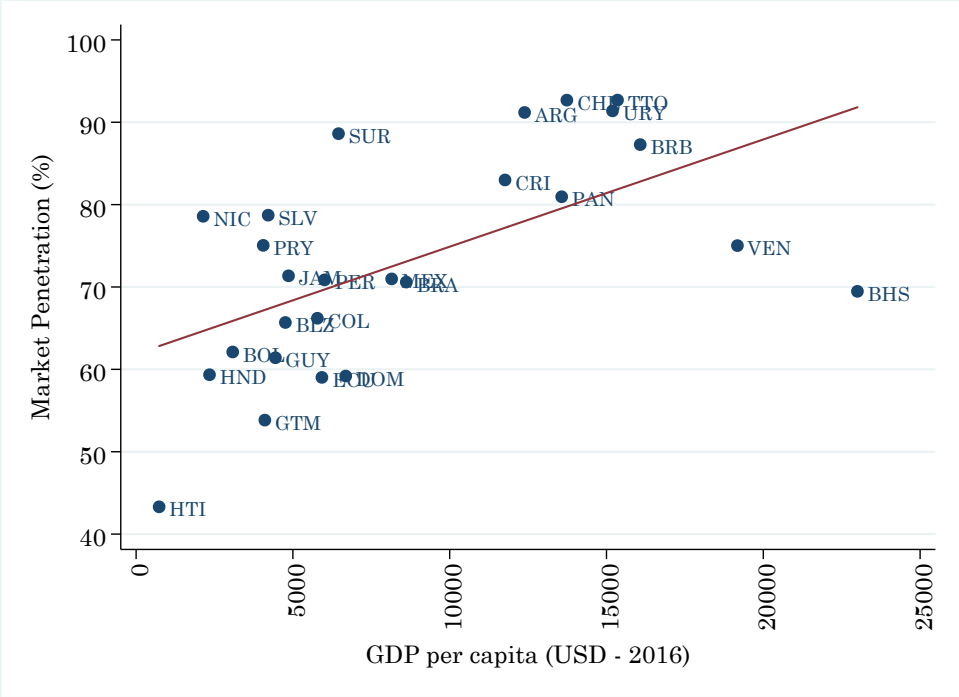


For the region as a whole, we can observe the access to mobile phone has increased considerably on from 2000 to 2017. On the beginning of the decade of 2000, all countries had a penetration rate less than 20%, while by the year of 2017, for all countries but Haiti, more than half of their population already had access to it. The disparity on penetration rates among countries can be partially explained by their differences in economic development. The correlation between market penetration and economic development is 0.56, and it is statistically significantly different from zero at the 1% level. Figure 2 plots each Latin American country by income, GDP per capita, as of 2016, in U.S. dollars, and market penetration, as of the fourth quarter of 2016. With the exception of Venezuela and the Bahamas, represented by the rightmost two dots, all countries whose GDP per capita is above USD 10,000 present a market penetration above 80%. Meanwhile, all countries whose GDP per capita is below USD 5,000 have a market penetration below 80%.

As observed, the evolution of market penetration differs among countries: the speed with which countries reached their current state was different, and there are some markets where penetration is still far from being considered saturated. Countries like Honduras (60% penetration rate), Bahamas, Venezuela (about 70% penetration rate), Barbados and Trinidad and Tobago (above 90% penetration rate) achieved their current rates relatively fast: by 2008-10, they had almost achieved their 2017 coverage levels. That is, these countries exhibited a high increase in penetration rate from 2000 to 2010, and stabilized after that. Note that this not mean all these countries achieved market saturation

though, as observed in Honduras, Bahamas, and Venezuela. Other countries such as Colombia and Ecuador (about 65% penetration rate), Brazil, Jamaica, and Paraguay (70%), and Argentina, Chile, and Uruguay (above 90%) experienced a more steady expansion process, achieving their current penetration rates between 2011 and 2014. Colombia and Ecuador are worth noting, because they reached the 50% penetration rate mark very early, by 2006, but after that initial period of high speed coverage expansion the process stalled. It took them another 6 to 8 years to achieve 60-65% (just an additional 10-15% from their 2006 coverage level) and they have not grown since. Finally, other countries like Belize, Bolivia, Dominican Republic, and Guyana (about 60% penetration rate), Mexico, Peru (above 70%), Nicaragua, Panama, and Suriname (above 80%) only achieve their current rates by 2015-17, and with the exception of Suriname, which may have achieved its saturation rate, they may continue to expand their coverage rates in the coming years if the present trend continues. In the Appendix, Figure A1 presents the evolution of market penetration for each of the 26 countries.

Figure 2. GDP Per Capita and Market Penetration (2016)



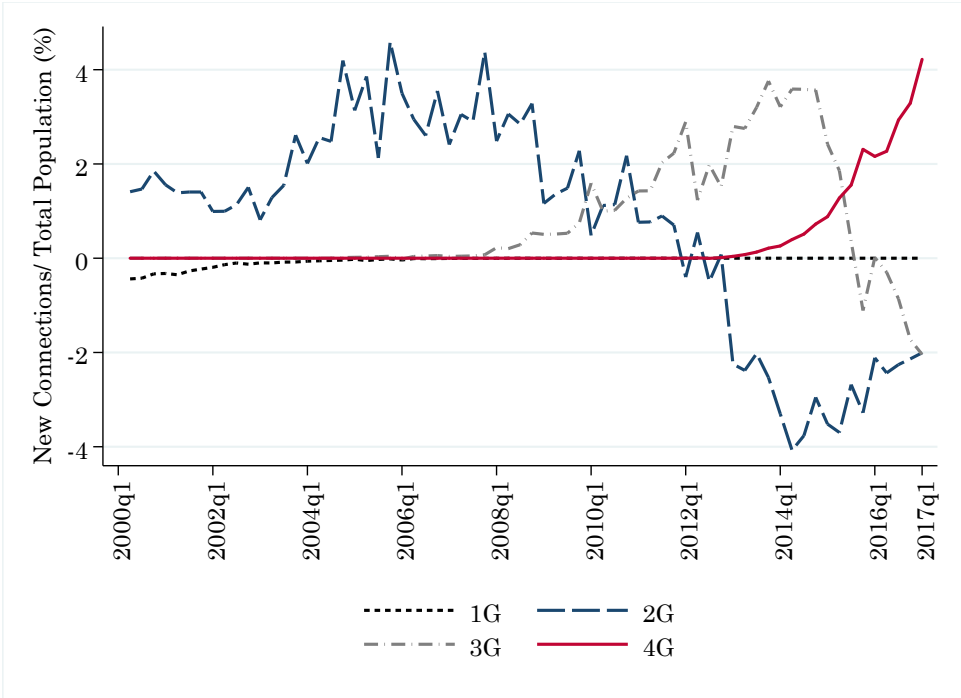
4 Adoption of New Technologies

Although adoption of mobile phones is already close to 80%, the development of new technologies that improve the capabilities of mobile devices creates a continuing demand for new investments in the telecommunication industry. During the period of 2000 to 2017, we witnessed: (i) the demise of

the first (analogue) technology generation, (ii) the dawn and dusk of the 2G, (iii) the dawn of 3G and its current lost appeal to customers, and (iv) the emergence of the latest 4G. Figure 3 presents these trends by plotting the rate of new connections by technology generation.

It must be noted that the life-cycle of each new technology is getting shorter. This phenomenon, when newer technologies overcome older technologies at a faster pace, making the latest technology dominance period shorter and shorter, it is known as leap-frog. We observe this leap-frog pattern in LAC over our sample-period. The adoption of the second generation (2G) of mobile phone technology started to accelerate in the first quarter of 2004, when the rate of new connections reached the mark of 2% of the population for the first time. This rate remained above the 2% level until the first quarter of 2009, making the expansion of the 2G the longest of all four, at 5 years on total. In the first quarter of 2010, the rate of new connections of the third generation surpassed the 2G rate for the first time. However, it was only one year later that the 3G expansion began to accelerate. The 2% mark of new connections for the third generation was reached on the fourth quarter of 2011 and it remained above this level until the third quarter of 2015. Therefore, the 3G expansion period lasted almost four years. Finally, the demise of the 3G expansion, by falling below the 2% mark on the third quarter of 2015, was subsequently followed by the adoption of the fourth generation, that reached the 2% mark no later than the first quarter of 2016.⁶

Figure 3. Quarterly New Connections by Technology Generation



⁶ In the Appendix, Figure A3 presents the evolution of total connections by country and technology generation.

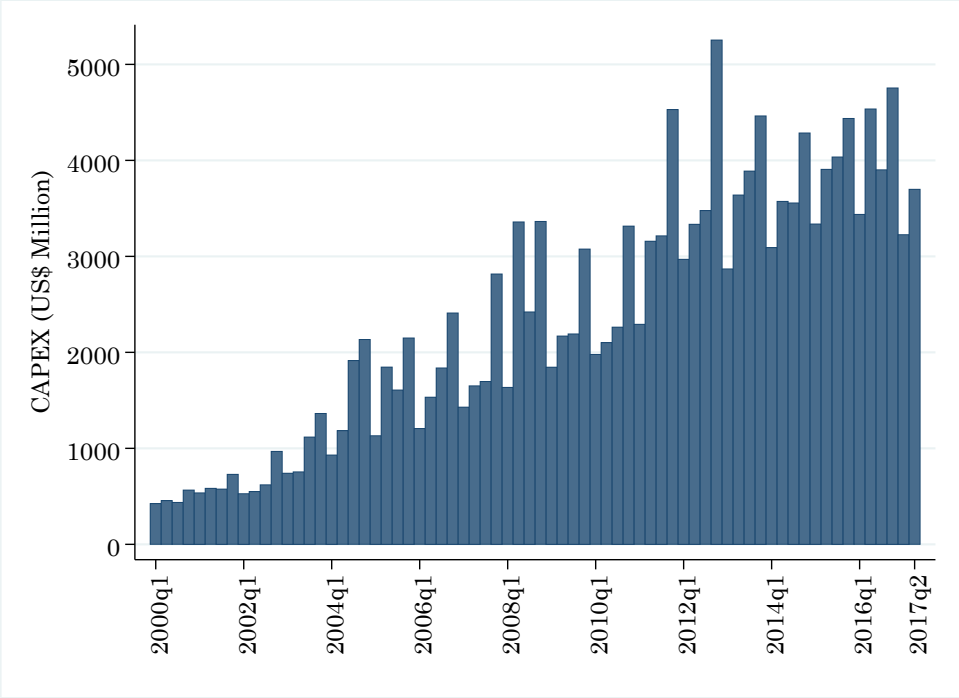
In 2009, the access to a mobile phone reached more than half of the population of the region under the 2G technology. It is natural that when the 3G technology became available, it would not only allure customers that did not had a mobile phone but also the ones that wanted to upgrade to a better access. Therefore, given the limitation on the size of the market and the dawn of the new 3G technology, the number of existing 2G connections eventually started to diminish. On the first quarter of 2012, the rate of (net) connections reached the negative side (net disconnections) for the first time, indicating that the 2G technology was already being substituted by the then new 3G generation. The rate of 2G disconnections reached its peak of almost 4% per quarter in the beginning of 2014 and it has been losing users since then. From its peak of expansion on 2006Q1 to the peak of disconnections on 2014Q1, the cycle of 2G technology lasted 8 years. On the other hand, the 3G technology, from its peak expansion on 2013Q4 to the highest rate of disconnections on 2017Q1, there were less than 4 years, a cycle that was less than half than the one for 2G. It remains to be seen if when the unserved customers in LAC (those in rural isolated areas and the urban poor) are reached, they choose the latest technology (i.e. 4G or future technologies) or something older and more affordable like 3G, which may extend the life-cycle of this technology.

5 Investments

The expansion of the access to mobile phones and the subsequent evolution of the technology required massive investments by the telecommunication industry. Figure 4 shows that the sum of the capital expenditures (CAPEX) on all of the 26 IDB-borrowing member countries increased from less than one billion dollars per quarter in 2000 to more than 3 billion per quarter from 2012 to 2017, with peaks above 4 billion. The disaggregation using quarterly frequency allows us to observe that most of the spikes on capital expenditures happen on the fourth calendar quarter of each year. This pattern is in line with most of the literature of corporate investments that shows the vast majority of companies matches their last fiscal quarter with the last calendar quarter. In most countries, a portion of capital expenditures may be deducted to reduce annual income tax, and as a result firms have an incentive to increase these expenditures during the final fiscal quarter of the year to minimize tax obligations. According to our data, the telecommunication industry is no exception to this pattern. The analysis at the country level shows heterogeneity across countries. While each country follows its own trend, three general patterns can be observed. First, countries like Brazil, Chile, Colombia and Panama reached their highest investment levels before 2006. These countries made big investments early, deploying most of their networks for the 2G technology. Later investments

were destined to upgrade systems and expand coverage to areas not already covered. Other countries such as Belize, Bolivia, Dominican Republic, Guyana and Paraguay exhibit an earlier, lower investment peak between 2004 and 2008, and a later, higher peak by 2013-14. These countries made some early investments to deploy mobile services in some areas, but had still significant coverage gaps to be filled by 2010. A second wave of investments was destined to fill these gaps and to upgrade systems to 3G. Finally, countries like Costa Rica, El Salvador, Honduras and Jamaica made most of their investments late in our sample period, after 2008-09.⁷

Figure 4. Quarterly Capital Expenditures (US\$ Million).

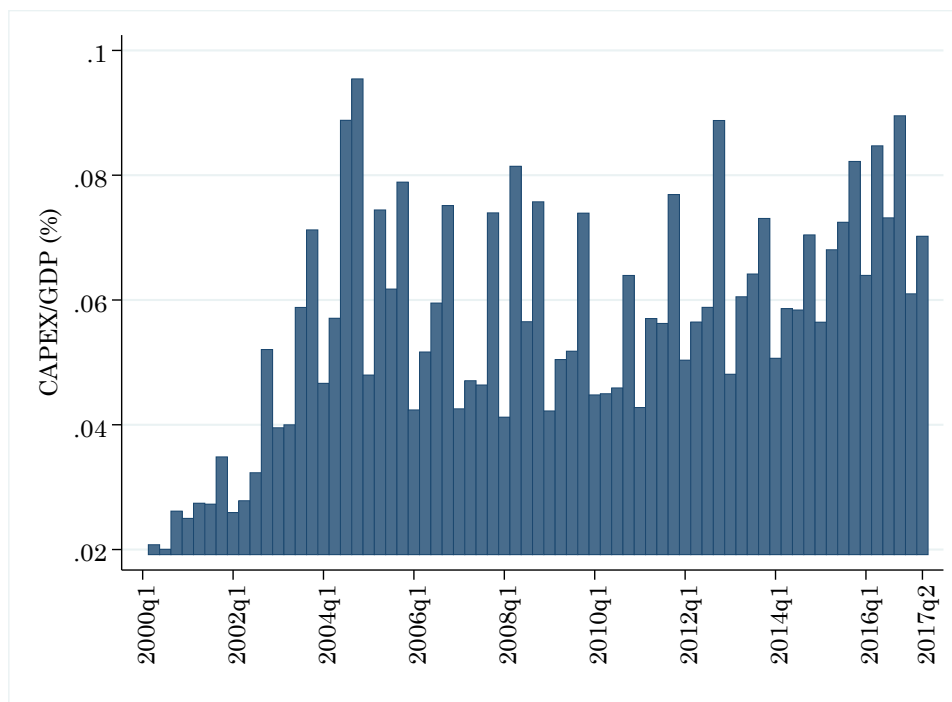


It is possible to argue that LAC countries experienced a period of strong economic expansion during the decade of 2000 and, therefore, the increase in investments by the telecommunication industry could be capturing only the natural growth of these economies. However, when we analyze the capital expenditures of telecommunication companies over the GDP of the region, Figure 5 shows that there was also an increase in the share of total investment. From 2000 to 2003, annual investments represented less than 0.1% of the GDP. As the second generation technology started to increase the access to mobile phones, CAPEX over GDP reached an annual average of 0.2% of the economy from 2004 to 2012, and with the advent of the third and fourth generation it reached 0.25% of GDP from 2012 until 2017.

To investigate how telecommunication companies financed their expansion under each technol-

⁷ On the Appendix, Figure A2 presents the time series of the telecommunication industry CAPEX by country.

Figure 5. Quarterly Capital Expenditures over GDP.



ogy generation we would need to analyze their access to internal and external funding. Although this issue is outside the scope of this study, a few insights can be made. By the theory of pecking order (see for example Myers and Majluf 1984, Quan, 2002; Ronconi and Kawamura, 2015, for LAC), companies should first use internally generated funds to finance their investments. Cash flow from operating activities have a lower cost compared to external funds, such as debt and new issuance of equity. On the early 2000's, as market penetration was low, the ability to generate revenue compared to the necessity of investment was limited, probably requiring funding from external sources. As a first step, we analyze the evolution of the CAPEX as a share of the total revenue. Figure 6 shows that from 2000 to 2003 telecommunication companies invested less than 10% of their revenue. Once again, matching the period of the expansion of access to mobile phone, in 2004 the average quarterly investment reached almost 15% of the revenue. On the subsequent years, CAPEX as share of revenue was kept on levels around 10% of the revenue. Finally, matching the advent of the fourth generation, we can observe a spike in this ratio to more than 20% since 2015.⁸

Indeed, Figure 7 shows that it was on 2004, the year when the number of new subscribers accelerated the most, that investment reached its highest amount at almost USD16 per subscriber.⁹ Given a first boom on the subscriber's base and the consequent increase in their revenue, it is likely telecom-

⁸ On the Appendix, Figure A5 shows the dynamics of the CAPEX revenue ratio by country.

⁹ On the Appendix, Figure A6 presents the evolution of investments per subscriber by country.

munication companies switched from a majorly external funding strategy to investments that were financed more with internally generated funds. This hypothesis would explain why CAPEX as share of revenue increased substantially after 2014.

Figure 6. Quarterly Capital Expenditures over Revenue.

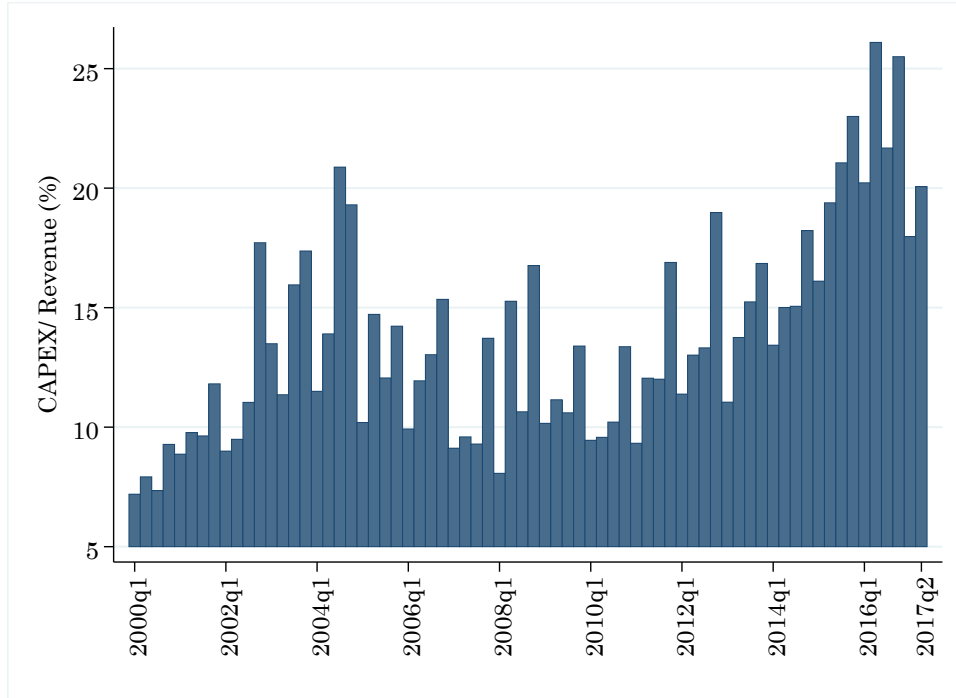
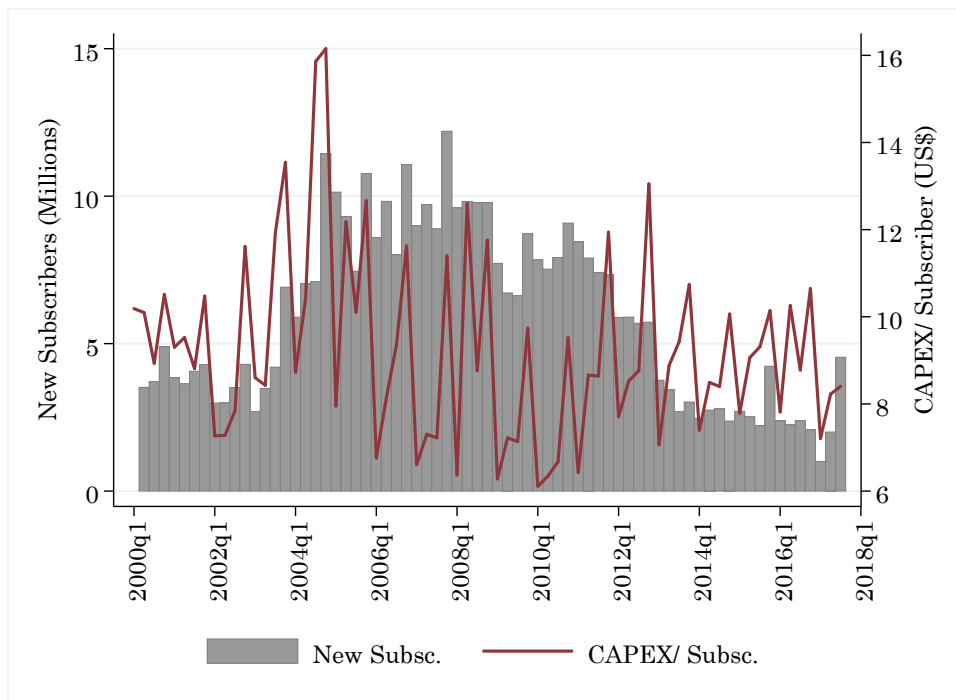


Figure 7. New Subscribers and Need for Investments



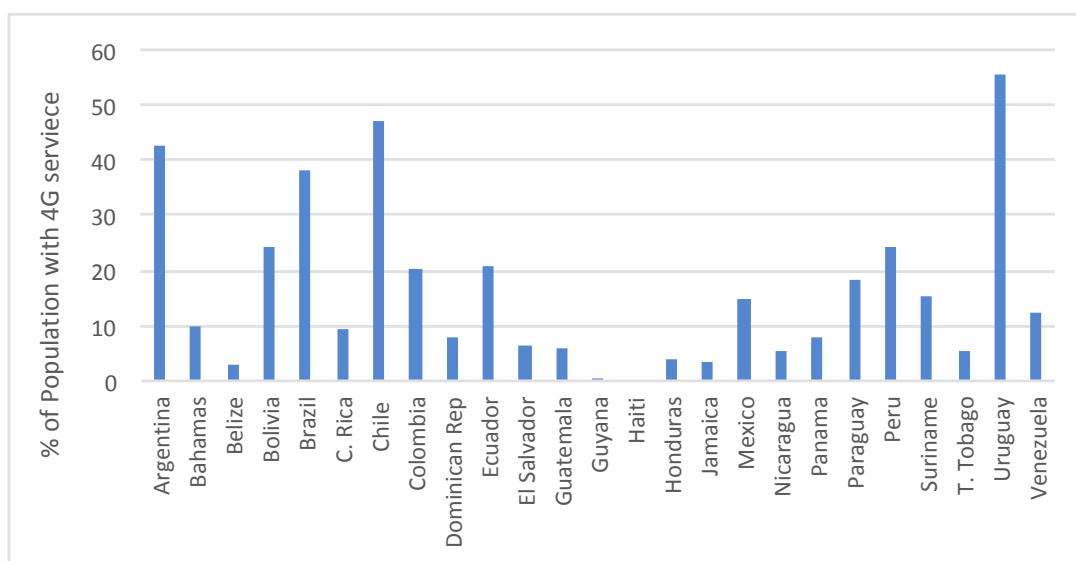
6 Quality and Development Impact

Access to mobile services does not mean access to mobile *quality* services. Access to mobile services is a necessary condition, but is a basic one. It is by no means an end in itself. In a dynamic, fast-paced changing, innovative industry, basic access does not mean much. The key to enjoy most of the related services and possibilities lies in having access to a quality service with the latest technology.

While mobile coverage and adoption rates have been growing constantly since 2000, there is still great room for improvement in the quality dimension. Today, having access to a mobile service is not enough. In order to take full advantage of the possibilities offered by modern technologies, it is imperative to have access to a quality service.

As mentioned in section 3, about 70% of LAC population has access to the service. However, less than 20% has adopted the 4G technology, the one that provides access to the most applications, and the one that has the biggest potential to have a development impact. The LAC average 4G adoption rate is 17% (see Figure 8), although the situation varies by country. On the one hand, Uruguay 4G adoption rate is above 50%, Argentina and Chile are above 40% and Brazil is about to reach 40%. On the other extreme, many Central American and Caribbean countries have 4G adoption rates below 10%.

Figure 8. 4G Adoption rate (% of Population)



About 40% of LAC connections are still working on 2G, and another 40% on 3G. The problem with these older technologies is that they run on lower speeds and they are not as capable as 4G to provide access to many value added applications. 4G is up to ten times faster (in download speed) than 3G. These faster speeds allow users and firms to use more and better services. For example,

a download speed of 2Mbps allows emailing and simple web browsing, 4Mbps allows full web browsing and using online payments applications, 6 to 8 Mbps are required to do video-conferences and 25Mbps allows HD video streaming. How are these speeds related to the mobile technology? While the question is difficult to answer, since actual network speed depends on many factors such as technology, assigned bandwidth and spectrum frequency, on average 4G exhibits download speeds of 15-18Mbps, 3G achieves download speeds of 3-7Mbps, and 2G speeds of 0.1-0.3Mbps. Since 40% of LAC customers still use 2G, and a significant portion of the 3G customers are on the lower end of the speed range, it is clear that the majority of LAC customers do not have access to the broad range of possibilities offered by a quality service.

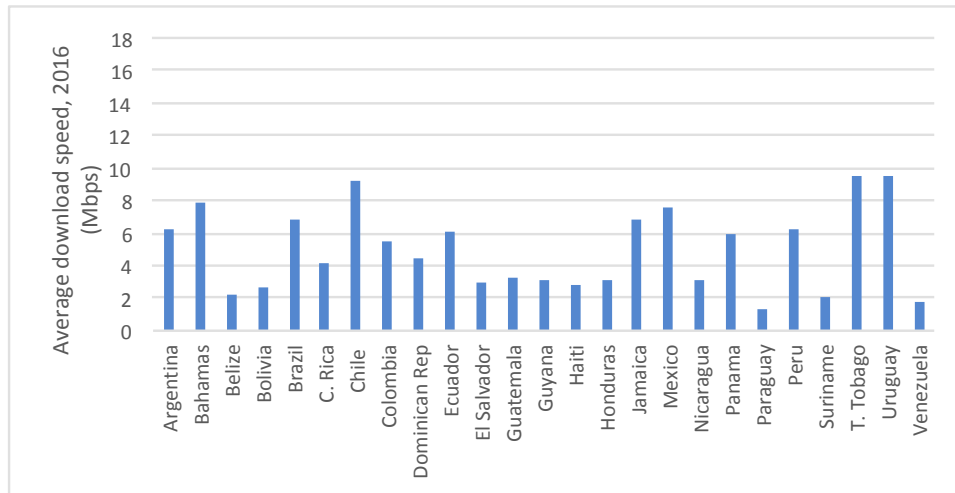
The importance of quality and speed have been recognized by the UK regulator, Ofcom, and by the US regulator, the FCC, when defining what is considered broadband. For the Ofcom, a user has broadband service if the download speed is at least 24Mbps. A user with access to a download speed of at least 10Mbps is considered to have *decent* broadband. In the US, the FCC defines broadband service as those that have a download speed of at least 25Mbps. In LAC, we are far away from those standards. As of 2017 Q3, no LAC country has an average download speed of 10Mbps or more (Akamai Technologies, 2017), see Figure 9. There is no LAC country where the average user has *decent* broadband, according to the definition of the Ofcom. Chile, Trinidad and Tobago and Uruguay have an average speed of a little more than 9Mbps and Bahamas 8Mbps. On the other side, Belize, Paraguay and Suriname have average download speeds of about 2Mbps.

Of course, the situation is not equal within countries. Some users in many LAC countries (not all of them, though) do have access to download speeds of 10Mbps or more (see Figure 10). However, they are the exception rather than the rule. More than 30% of users in Chile, Trinidad and Tobago and Uruguay have a service with at least 10Mbps, while more than 20% of the users in Bahamas and Jamaica have decent broadband (Brazil and Mexico are very close to 20%). In Paraguay, Suriname and Venezuela no users have access to at least 10Mbps, and in Belize, El Salvador, Guatemala, Guyana and Nicaragua less than 3% of the customer base have decent broadband.

Clearly, if LAC users are to have access to the latest applications, the ones which have a biggest development impact, it is imperative to deploy as soon as possible the 4G technology and it is also critical to improve the quality (download speed) of the service. It is clear that under the current situation the average user in LAC has no access to some of the best applications. The situation is even more problematic for firms, which cannot access services that may increase their productivity and expand the markets for their products.

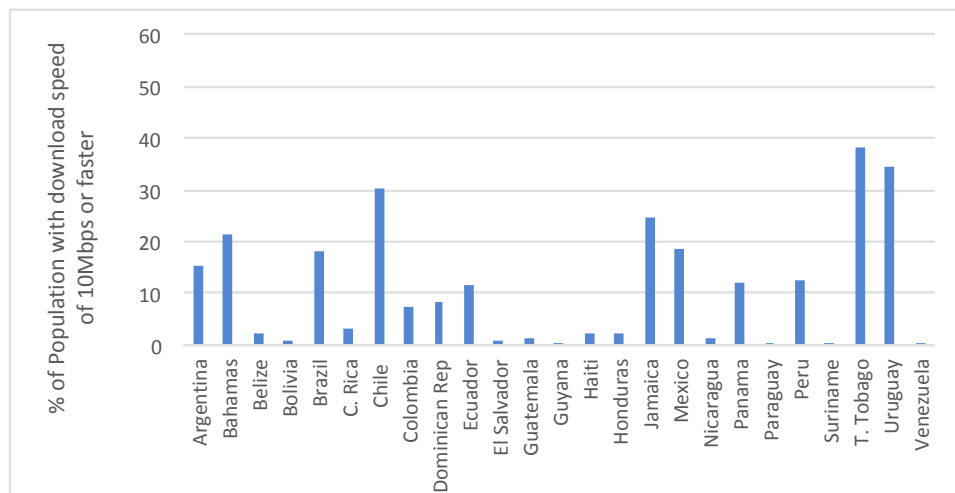
This lag in technology deployment hurts the region by increasing the digital gap with respect to

Figure 9. Average download speed (Mbps)



Source: Akamai Technologies, 2017.

Figure 10. Users with download speed of 10Mbps or more (% of Population)



Source: Akamai Technologies, 2017.

the more advanced economies, where the average user enjoys a download speed of 17.1Mbps, 58% of users have a download speed of at least 10Mbps and 69% of the population has adopted the 4G technology.

Additionally, the problem is present *within* each country. Those without access to higher speeds and better qualities are at a significant disadvantage with respect to the group with access. It is no surprise that the group at a disadvantage encompass the most vulnerable segments of the population: urban poor, rural small towns in general and rural women in particular. For 9 LAC countries where disaggregated data is available, the access gap between urban and rural population was 20%

in 2011 (ECLAC, 2013). For LAC, the challenge is to achieve digital inclusion as soon as possible.

7 Market Structure and Regulatory Issues

The telecommunication industry is the most deregulated infrastructure sector. Unlike energy transmission and distribution or water and sanitation provision, the telecommunication sector has seen a great deal of private involvement since the early 1990's. Prices and service packages offered are freely determined by the firms in the market in almost all Latin American countries. While the industry is subject to regulatory oversight, the regulation focuses on technical aspects such as interconnection issues, number portability and spectrum allocation rather than on economic regulation of prices and quantities. Private participation on investment is also the highest among infrastructure sectors in Latin America and the Caribbean. In the last 9 years, the private sector accounts for almost 80% of the investments in telecommunications, compared to 51% in energy and 3% in water and sanitation (Infralatam, 2017).

A deregulated environment leads to the absence of monopolies and extensive private participation across the region. All LAC countries have at least one private operator and at least two firms in the market. However, the industry is far from perfectly competitive and it remains concentrated. Few big players dominate the sector in all LAC countries, sometimes mixed with one or two very small operators that concentrate on a specific market niche or geographical region within a country.

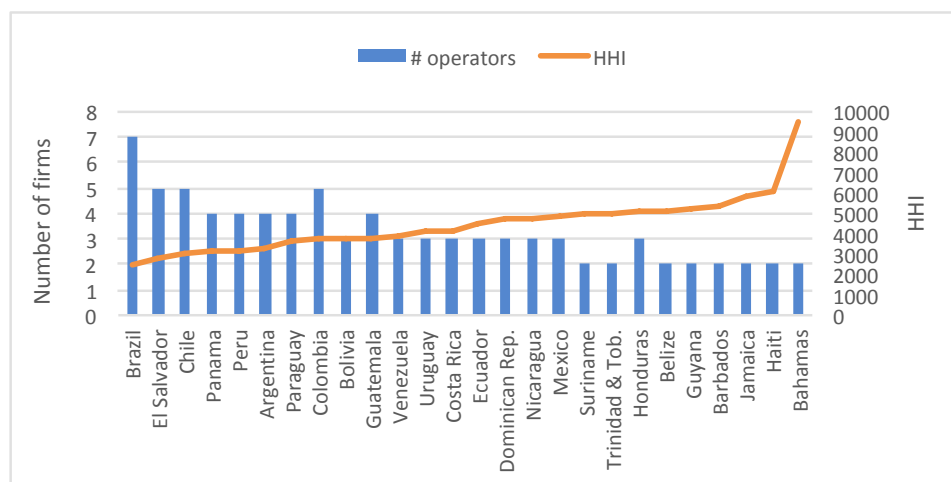
In all LAC countries, there are between 2 and 7 operators offering services at the end of 2017. Countries with only two operating firms are located in the Caribbean: Bahamas, Barbados, Belize, Guyana, Haiti, Jamaica, Suriname and Trinidad and Tobago are all in this group. Most of all non-Caribbean LAC countries have either 3 or 4 firms operating in their domestic markets. Countries in this group are heterogeneous. Some of them are big markets, like Argentina and Mexico, others are smaller markets such as Nicaragua and Bolivia. They are located all across South America (Uruguay, Paraguay, Peru, Venezuela) and across Central America (Costa Rica, Panama). Only four countries have 5 or more operators present in their markets. Brazil, the biggest market in the region, also has the most firms operating in a single market: 7. Chile, Colombia and El Salvador have 5 each.

Of course, the number of firms in a concentrated market is an imperfect indicator of competition. In the first place, firms may have very different sizes and different degree of market power. For example, in Brazil, Colombia and Paraguay there are very small operators that can be considered followers that do not have enough power to set prices or determine industry trends. In the case of Brazil and Colombia, two of the countries with more operators, there are very small firms that

operate only in regional markets and account for less than 1% of the market share. While there are 7 and 5 firms present in these countries, the number of firms with actual market power is clearly smaller than those figures.

A better measure of concentration is the Herfindahl Hirshman Index (HHI). This index sums the squares of the market shares for each firm in the market, and ranges from 0 (perfect competition, assuming many very small firms in the market with a negligible share each) to 10,000 (a monopoly, where one firm has a 100% of the share). Figure 11 depicts the number of operators and the HHI (on the right axes) for all LAC countries. The least concentrated markets according to the HHI are Brazil, El Salvador and Chile, all with and HHI lower than 3,000. Panama, Peru and Argentina have also relatively less concentrated markets (HHI lower than 3,300). The countries in the Caribbean have the most concentrated markets. Suriname, Trinidad and Tobago, Belize, Guyana, Barbados, Jamaica, Haiti and Bahamas have all HHI above 5,000. The case of Bahamas represents an extreme for the region: while there are two operators, the HHI is 9,486, almost at monopoly level, because the main firm (BTC, the historical operator, a mixed firm 49% controlled by the State, 51% private-controlled) had a share of 98% at the end of 2015. A new entrant, ALIV, who started operation in late 2016 is gaining customers, so it is possible that in the near future the level of concentration diminishes.

Figure 11. Number of firms per country and HHI



While there is a clear positive association between the number of firms present in the market and the HHI index (correlation coefficient is 0.73), for individual markets it may not always hold that more firms means less concentration. For example, Colombia, with 5 firms, has a more concentrated market than Panama or Peru, which have 4 firms each. The HHI for Colombia is 3,729 while the HHIs for Panama and Peru are approximately 3,100. This is due to the fact that one of the firms in the Colombian market is a very small regional operator that has a share of less than 1%. Even in

markets with the same number of firms it is possible to find very different levels of concentration. This is specially true in markets with just two or three firms. Among the markets with three firms, the HHI ranges from 3,750 in Bolivia to 5,045 in Honduras where Tigo, the historical operator still holds almost 60% of the market share. Many Caribbean markets have two similar-sized firms. The cases of Suriname and Trinidad and Tobago are text-book cases of symmetric duopolies: there are two firms in each market with roughly 50% share each. The HHIs for the two countries are 5,002 and 5,006 respectively, practically equal to the symmetric duopoly 5,000 value. The exception, as noted above, is Bahamas, where one operator serves almost the entire consumer base.

Even knowing the concentration level as measured by the HHI, it is not possible to determine in advance how fierce is the competition in the market. In some instances, two firms that provide a relatively homogeneous service (say, for example, similar price per minute and MB used, and similar combinations of minutes of voice/GB of data/text messages bundles) competing in price is enough to obtain an equilibrium similar to the one under perfect competition. On the other hand, if firms try to differentiate their products, or if they cater to different segments of consumers, it is likely that even with more than 3 or 4 firms the market equilibrium show some market power by the incumbent firms. Other factors may also impact the competitive pressure in the market. When the same established firms compete period after period, or in more than one market (multi-market competition), or prices are publicly available, it is easier to enforce (tacit) collusion schemes that generate equilibria closer to a classic duopoly or monopoly level rather than the competitive one.

Entry and exit. As new firms enter the market, it is harder to sustain a collusive-like equilibrium. As firms exit the market, it is easier to end up closer to the monopoly equilibrium. For the period under analysis (2000 Q1 to 2017 Q3), similar number of entries and exits have occurred. In almost all the cases, exits take the form of a merger or acquisition. Out of the 14 telecommunication firms that disappeared from LAC markets during this period, 13 were merged or acquired by other incumbent operators. In only one case the operator closed and exit the market: VTR, a Chilean operator that closed in 2013.

Multi-market competition. Firms in the telecommunication industry are seldom independent operators that have presence in just one country. Often, operators in a country belong to a telecommunication conglomerate or holding with presence in many countries. This holds for all the world and LAC operators are no exception.

Considering each individual operator in each LAC country as an independent firm, it is possible to find 85 different operators providing services in 2017. This figure represents active operators, that is, operators who are currently offering at least voice service in a LAC market. It does not include

operators which had presence at some point during the sample period, but which had exited the market by the end of 2016. Also, it does not include operators that have already installed some infrastructure but plan to start operations in 2018 or later. According to this figure, there is an average of 3.3 “independent” firms per country.

However, considering the parent group / holding of each of these “independent” operators, it is observed that most firms belong to one of a few conglomerates with extensive presence across the whole region. Out of the 85 individual firms in LAC countries, 52 (61%) belong to a telecommunication holding. Other 11 (13%) are State-Owned Enterprises (SOE). The remaining 22 operators (26%) are actual individual companies. Often, these belong to a media company (cable tv provider or multimedia conglomerate) that provides telecommunication services in individual countries.

The three biggest holdings are America Movil, Telefonica and Digicel. These three big holdings, combined, have presence in 23 of the 26 LAC IDB borrowing countries. The only countries where it is not possible to find an operator belonging to at least one of these conglomerates are Bahamas, Belize and Bolivia. America Movil, a Mexican conglomerate, is the most extended holding, with presence in 16 LAC countries. Telefonica’s operators are present in 14 LAC countries and Digicel’s in 8 countries.

Considering geographical strategies, there are two differentiated groups. America Movil and Telefonica compete in 13 markets across South and Central America, most notably in all the biggest LAC markets: Argentina, Brazil, Chile, Colombia, Mexico and Peru. Digicel concentrates its presence in the Caribbean, plus Panama and El Salvador. The biggest competitor for Digicel operators are Liberty Group operators. Liberty Group is a conglomerate with presence in only 4 IDB-Caribbean members (Bahamas, Barbados, Jamaica and Trinidad and Tobago) and Nicaragua, but it has extensive presence in the small non-IDB members Caribbean markets.

Millicom International, another big international conglomerate is present in four Central American countries, plus Colombia and Paraguay. Finally, there are two small local (regional) conglomerates: Telecom Argentina, with presence in Argentina and Paraguay, and Entel Chile, in Chile and Peru.

Public ownership. Since the deregulation of the telecommunication sector in the early 90’s, the sector is associated with private participation and ownership. Specially the mobile and internet segments.

However, the private sector is not alone in the industry. The public sector is also present in many countries of the region. There are SOEs offering mobile and internet services in eleven LAC countries. In seven countries, the SOE has a significant market share and is one of the biggest operators

Figure 12. Operators by Holding

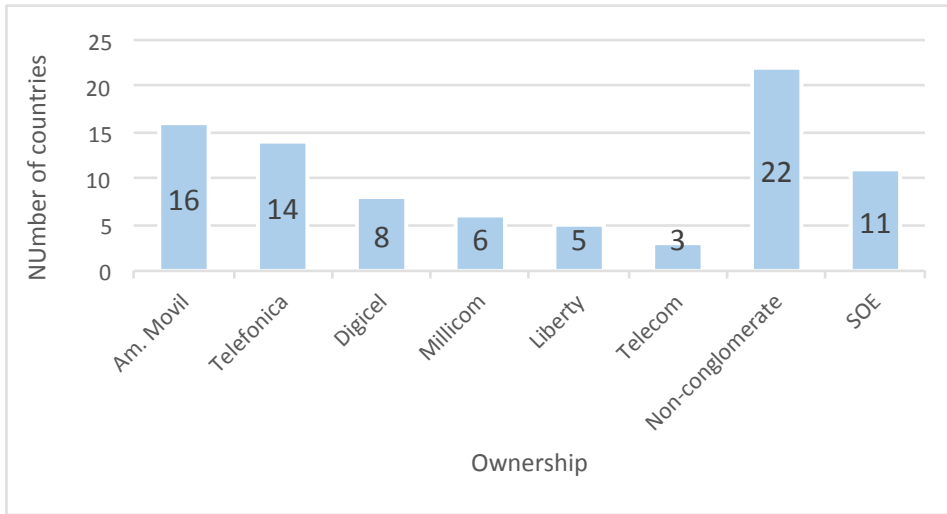
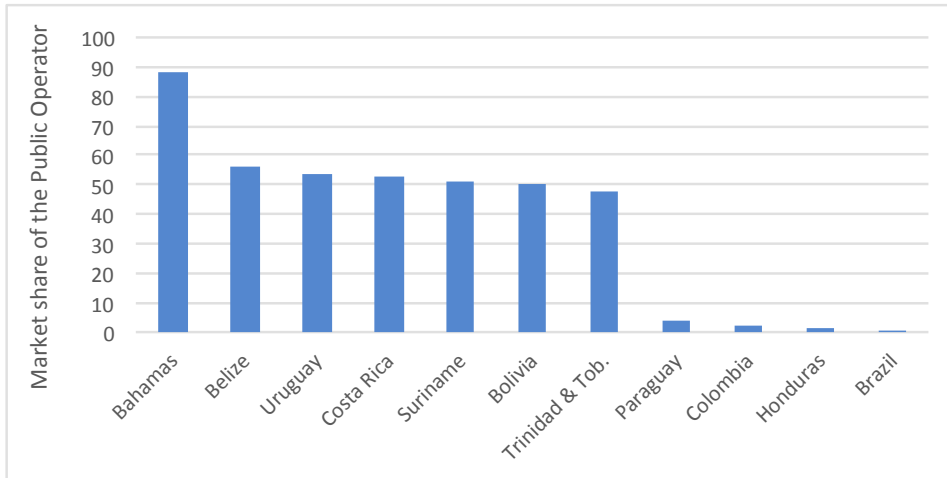


Figure 13. Public Sector Participation



in the market. In Bahamas (mixed firm), Belize, Bolivia, Costa Rica, Suriname, Trinidad and Tobago and Uruguay the public firm serves at least 40% of the customer base. In Bahamas, as discussed above, the mixed firm is the only regional quasi-monopoly, although its status is currently being challenged by the new entrant ALIV, which has taken over 10% of the market since 2016, and is expected to continue growing. In spite of this trend, BTC Bahamas will probably remain the largest operator in the country for the foreseeable future. In Bolivia, the SOE Entel had 40% of the market in the early 2000's, being second to Tigo's 60%. By 2005, Entel had surpassed Tigo and reached 62% of the market, until settling into the current 50% share. It is still the biggest firm in the market. Figure 13 show the State presence along with its market share in all LAC countries.

In other four countries (Brazil, Colombia, Honduras and Paraguay) the local SOE's market share

is very small: from about 4% in Paraguay to less than 0.1% in Brazil. In the case of Brazil and Colombia, local SOEs are very small because they serve specific local markets, rather than having national presence. Colombia had a bigger SOE, but it was acquired by Millicom in 2014. For Honduras and Paraguay, the SOE tries to serve as a reference point for customers in the market. They set prices that consumers can see as a benchmark when looking for service. These SOEs do not have the capacity to become bigger players in their respective markets and to compete with the private incumbents. In this case the role of the SOE is to send a signal and to create awareness of what is a reasonable prices in the market.

8 Concluding Remarks

In this study we presented major trends in the telecommunication industry for 26 countries that are IDB-borrowing members. Access to mobile phone increased from less than 10% of the population on the year of 2000 to more than 70% on 2017. Investments increased from less than 10% to more 20% of the revenue of telecommunication companies, and most of the expansion of the access to mobile phone occurred under the 2G technology.

The telecommunication industry is unique among infrastructure sectors in LAC, that were historically under the control of the government during periods of heavy investments. In mobile telecommunications, the majority of the expansion was carried out by the private sector. On the regulatory side, even as monopolies (public or private) are not strictly present, the telecommunication industry in Latin America should not be considered perfectly competitive as few players have most of the market.

Based on the analysis, the challenge for the region is double. On the one hand, it has to undertake investment in technologies to catch-up with the most advanced economies, to close the existing gap while also closing the internal gap so that the most vulnerable segments of the population are not left behind. On the other hand, the region needs to keep up with innovative projects if it wants to be at the frontier in the industry. In this dynamic, fast-changing industry, lack of innovation means lagging behind.

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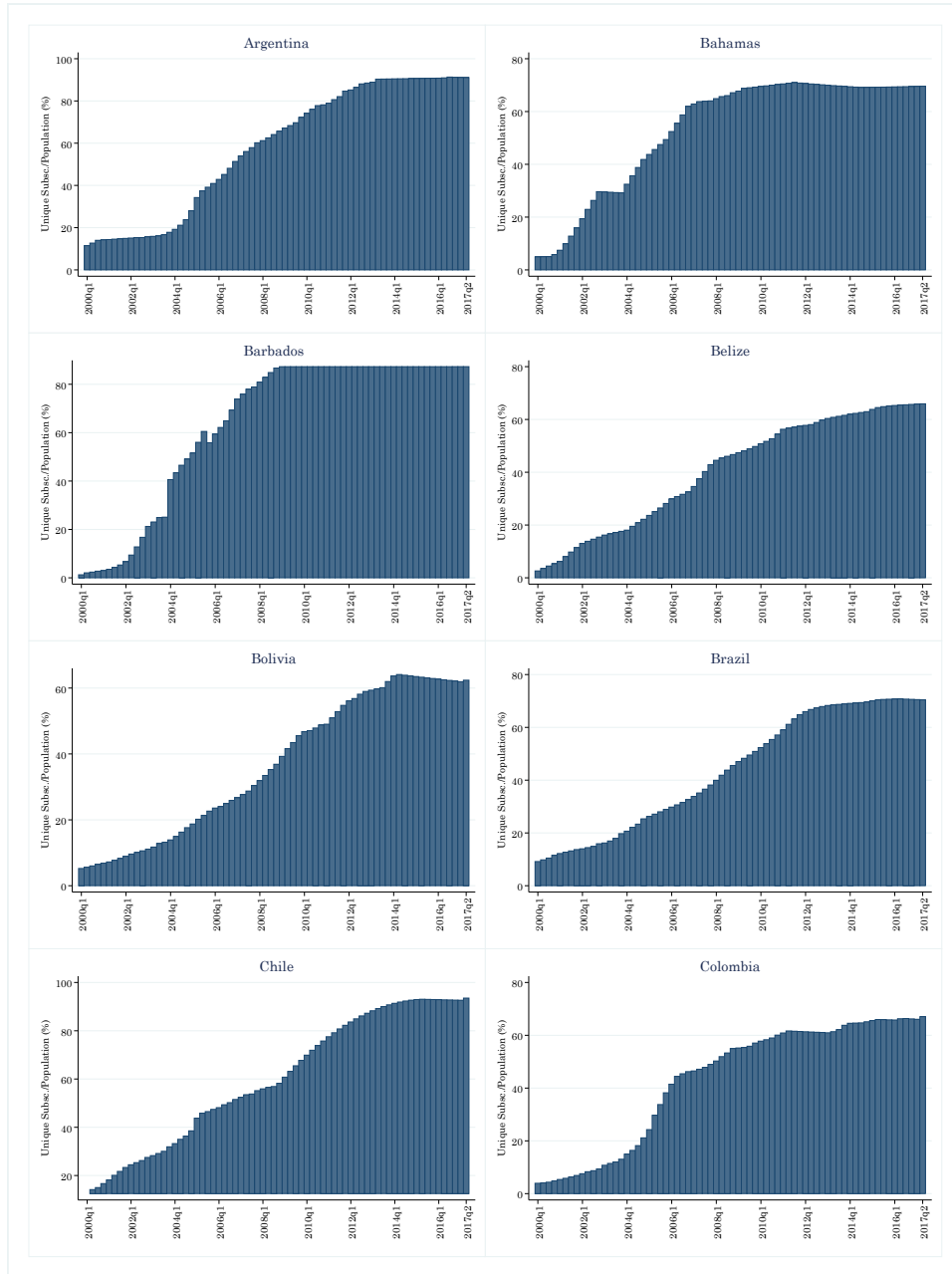
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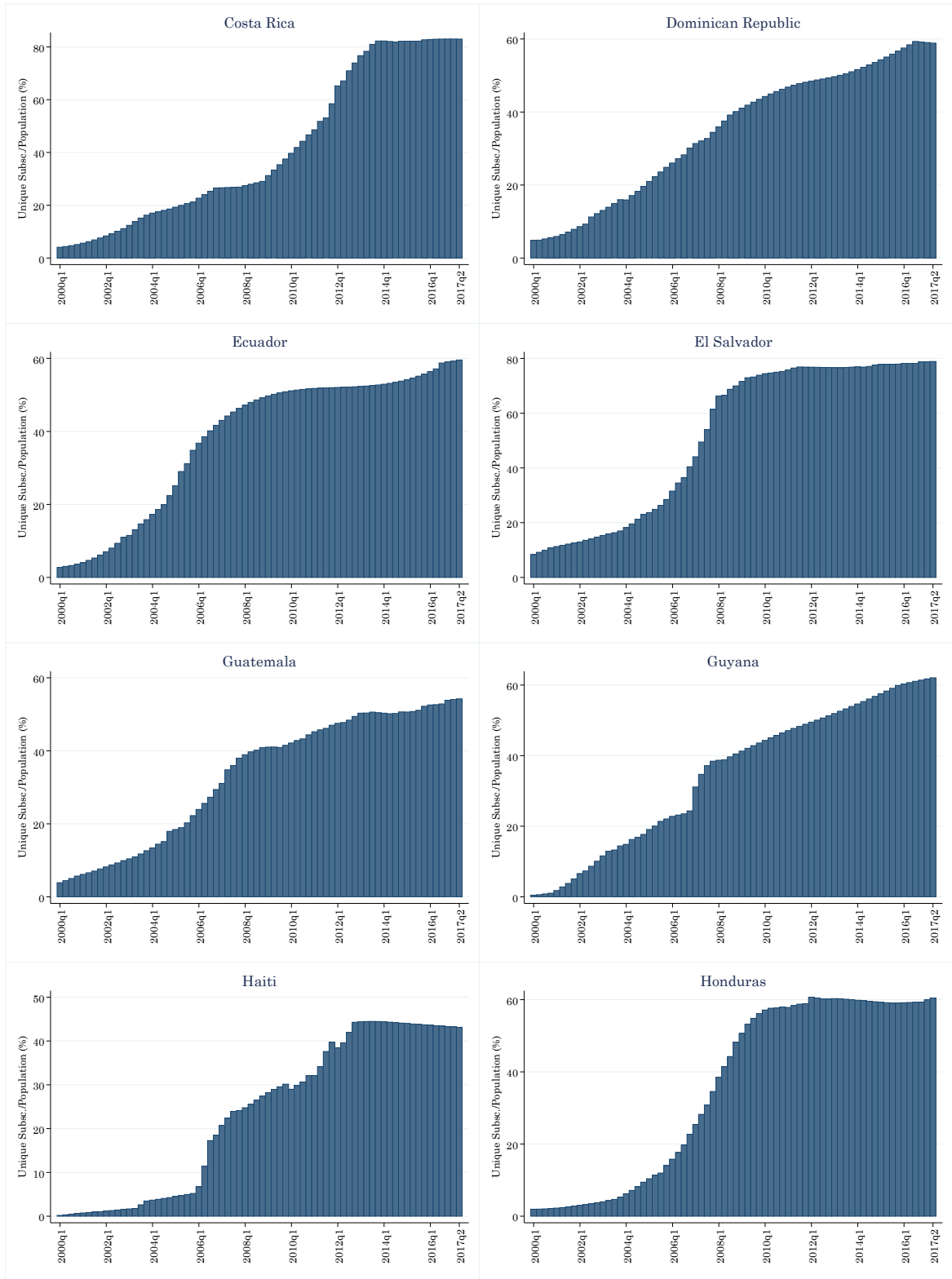
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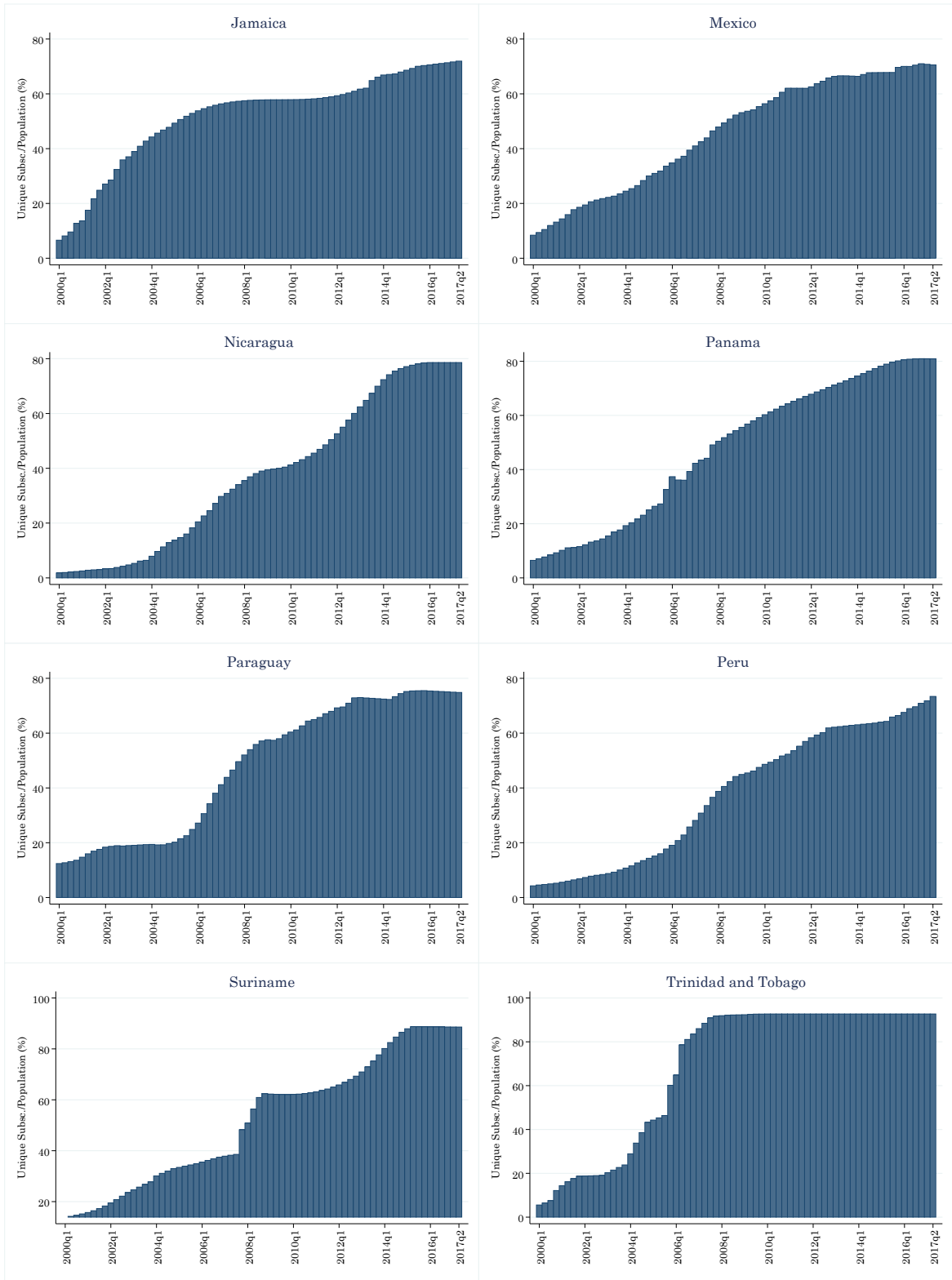
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Appendix

Figure A1. Market Penetration by Country







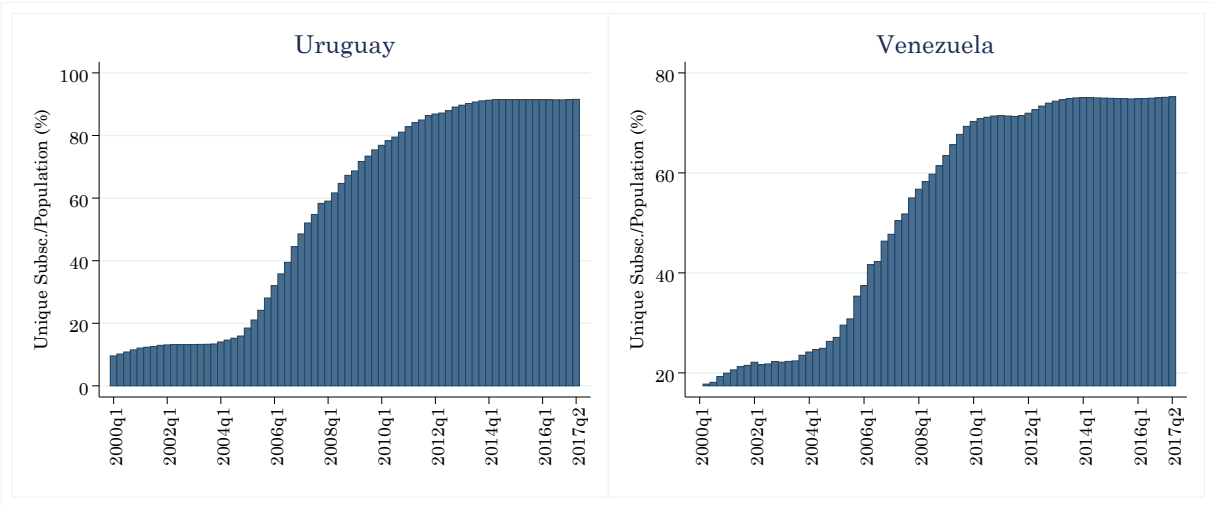
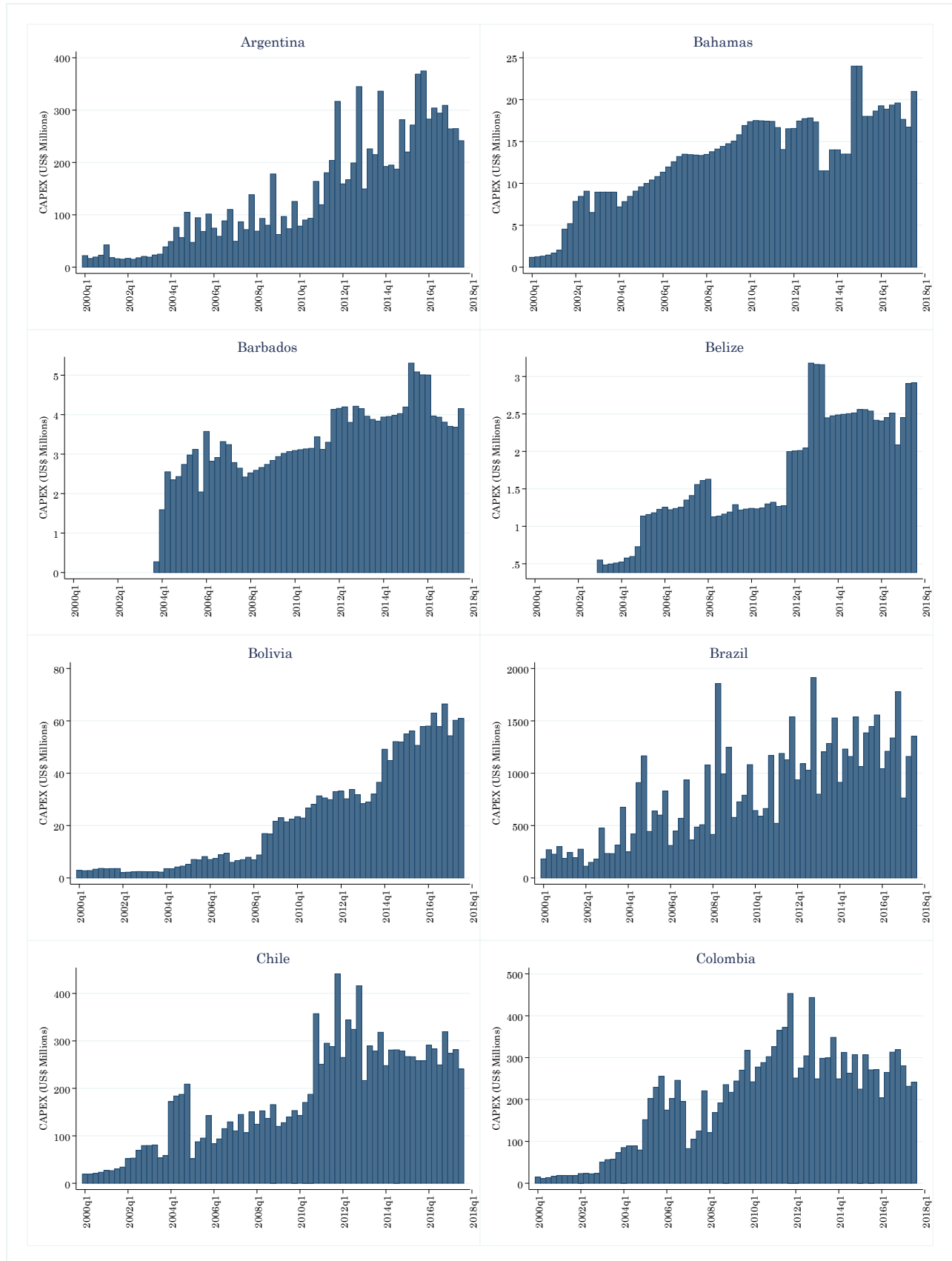
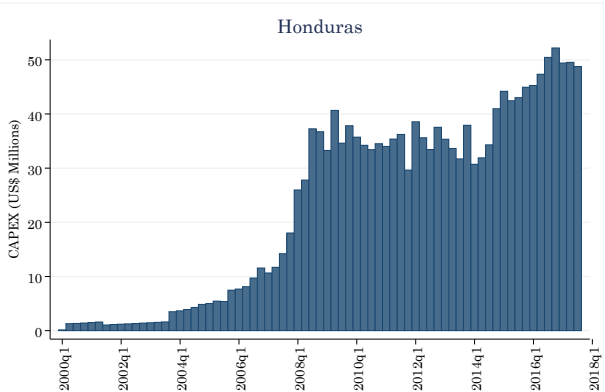
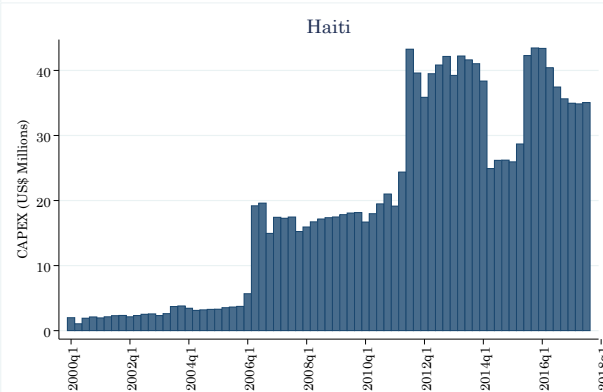
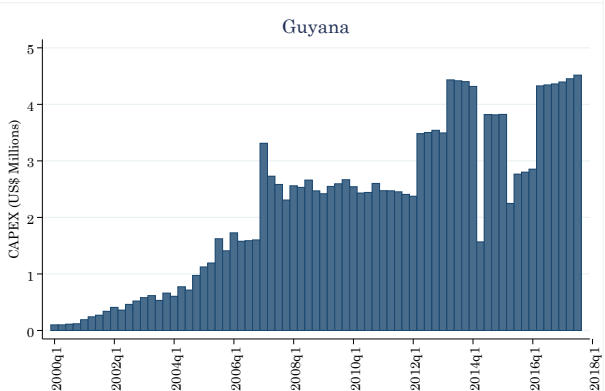
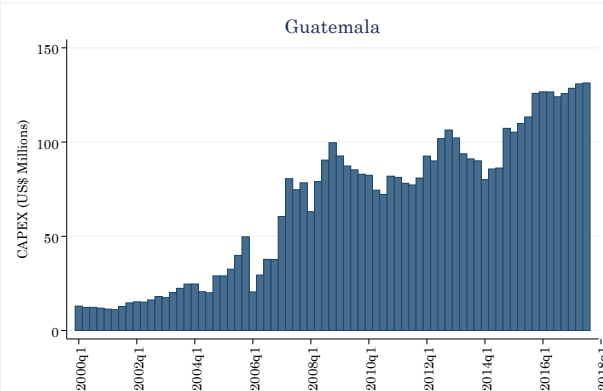
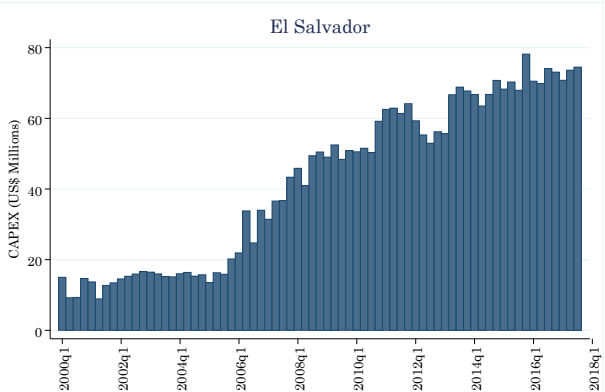
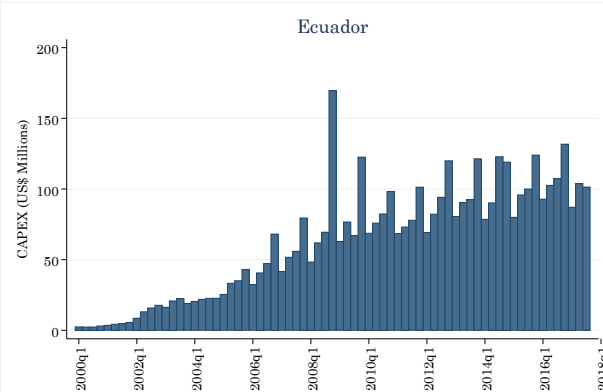
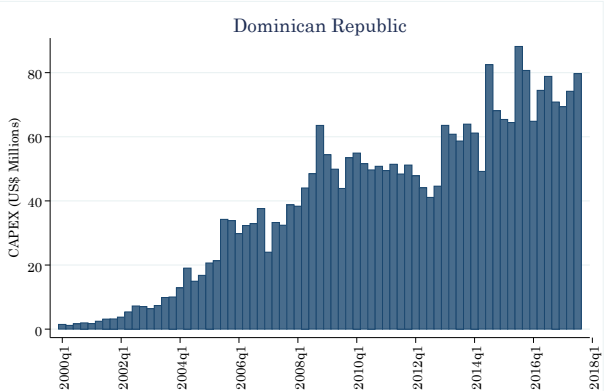
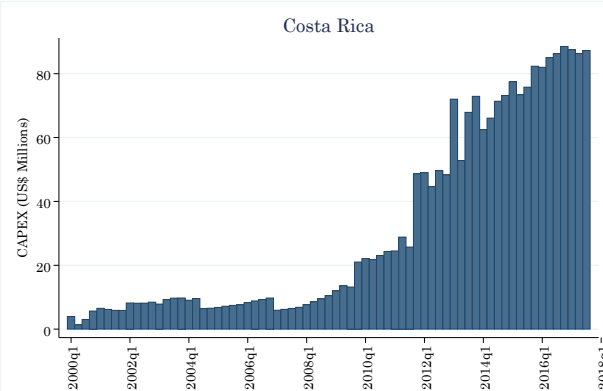
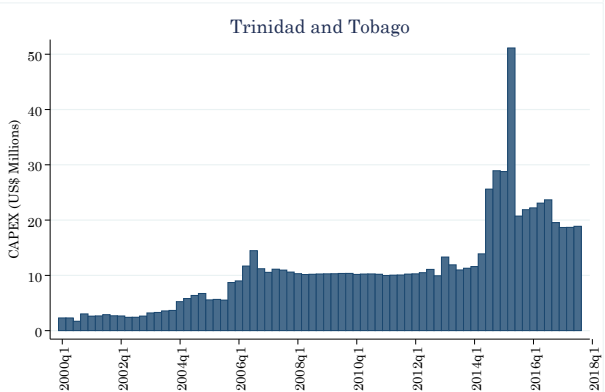
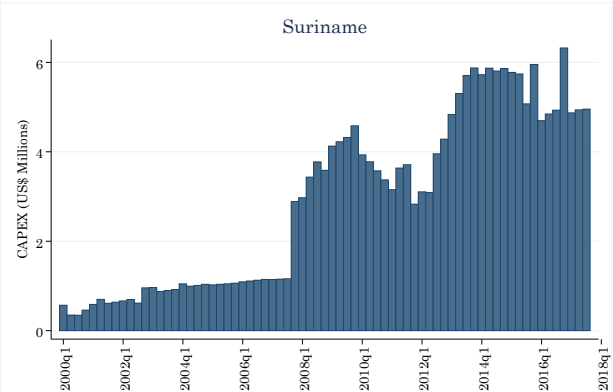
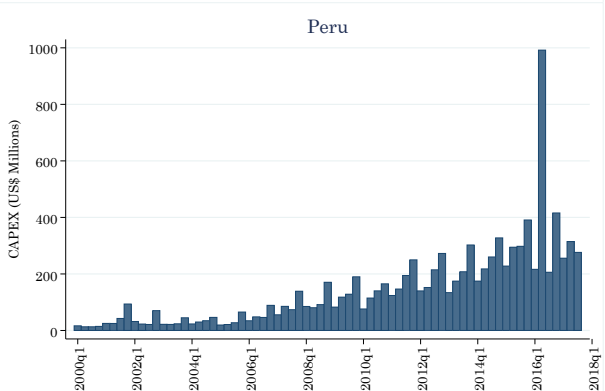
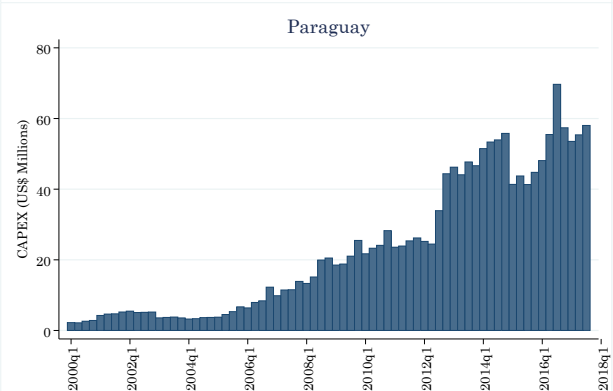
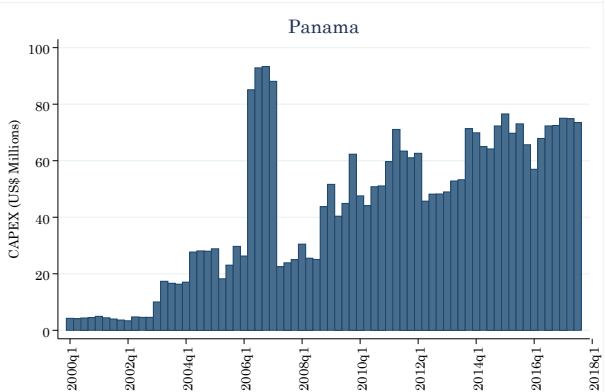
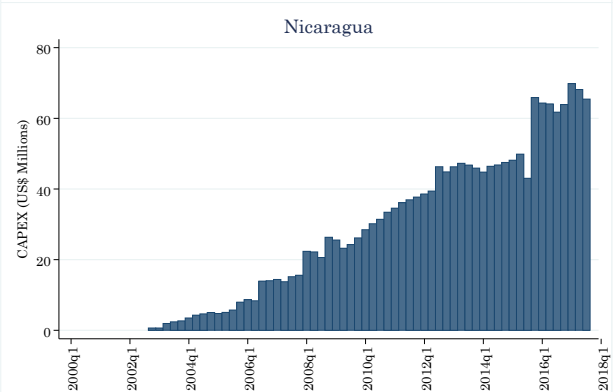
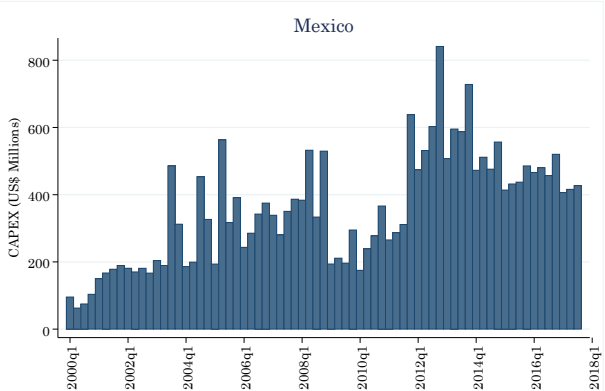
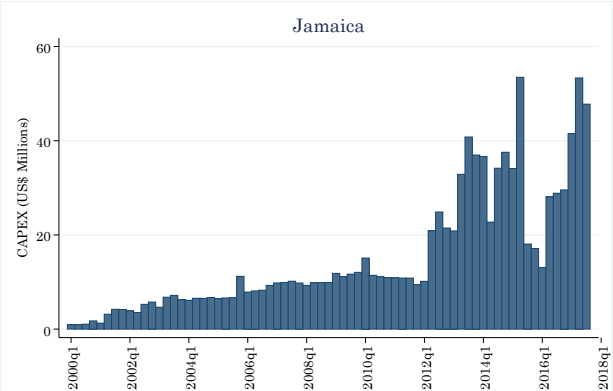


Figure A2. Quarterly Capital Expenditures by Country (US\$ Million).







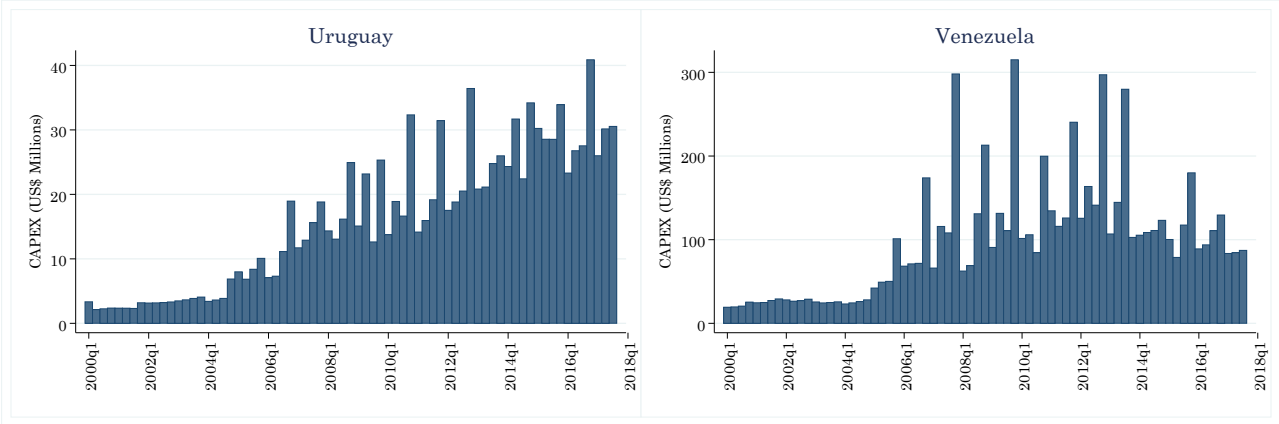
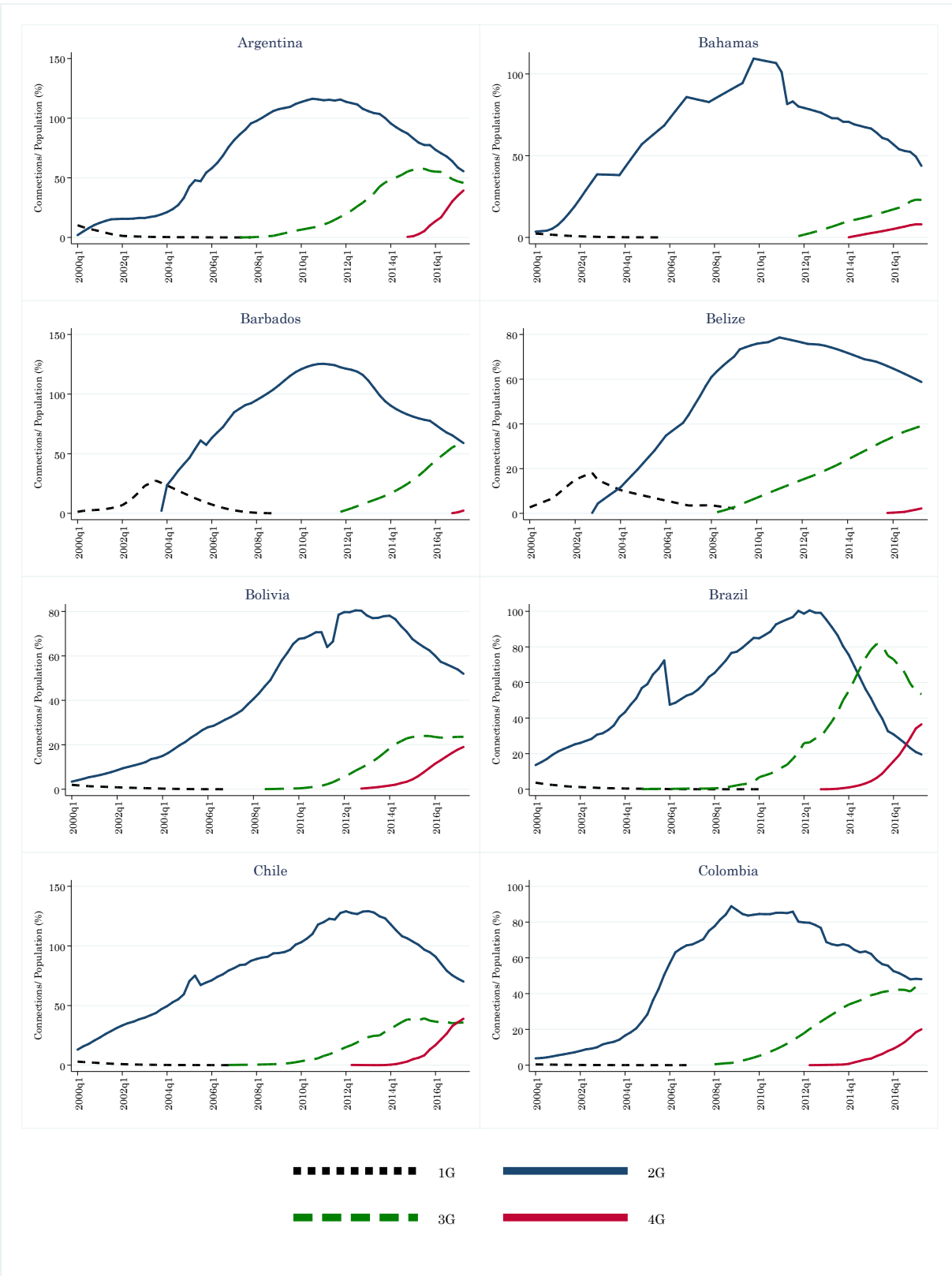
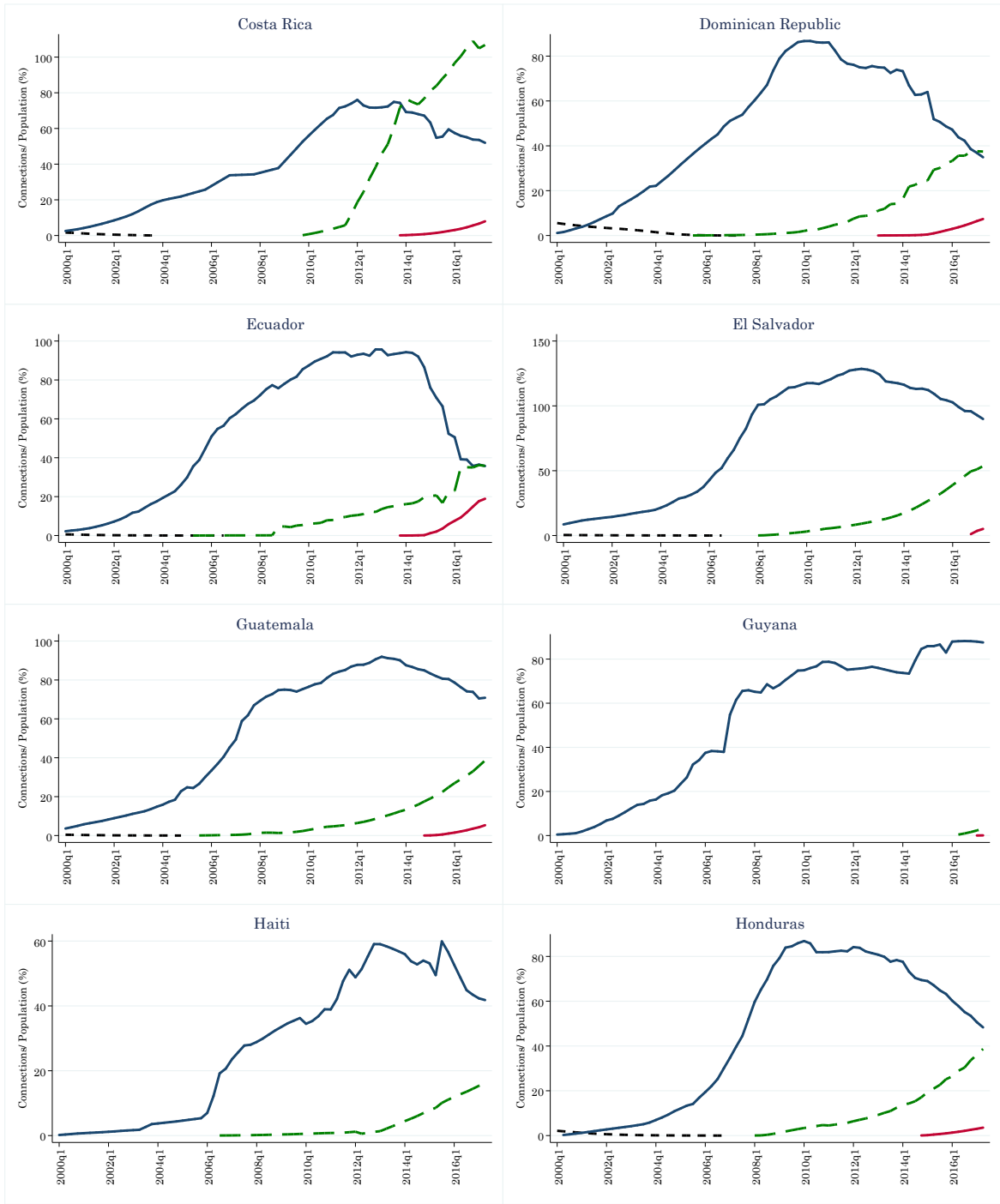
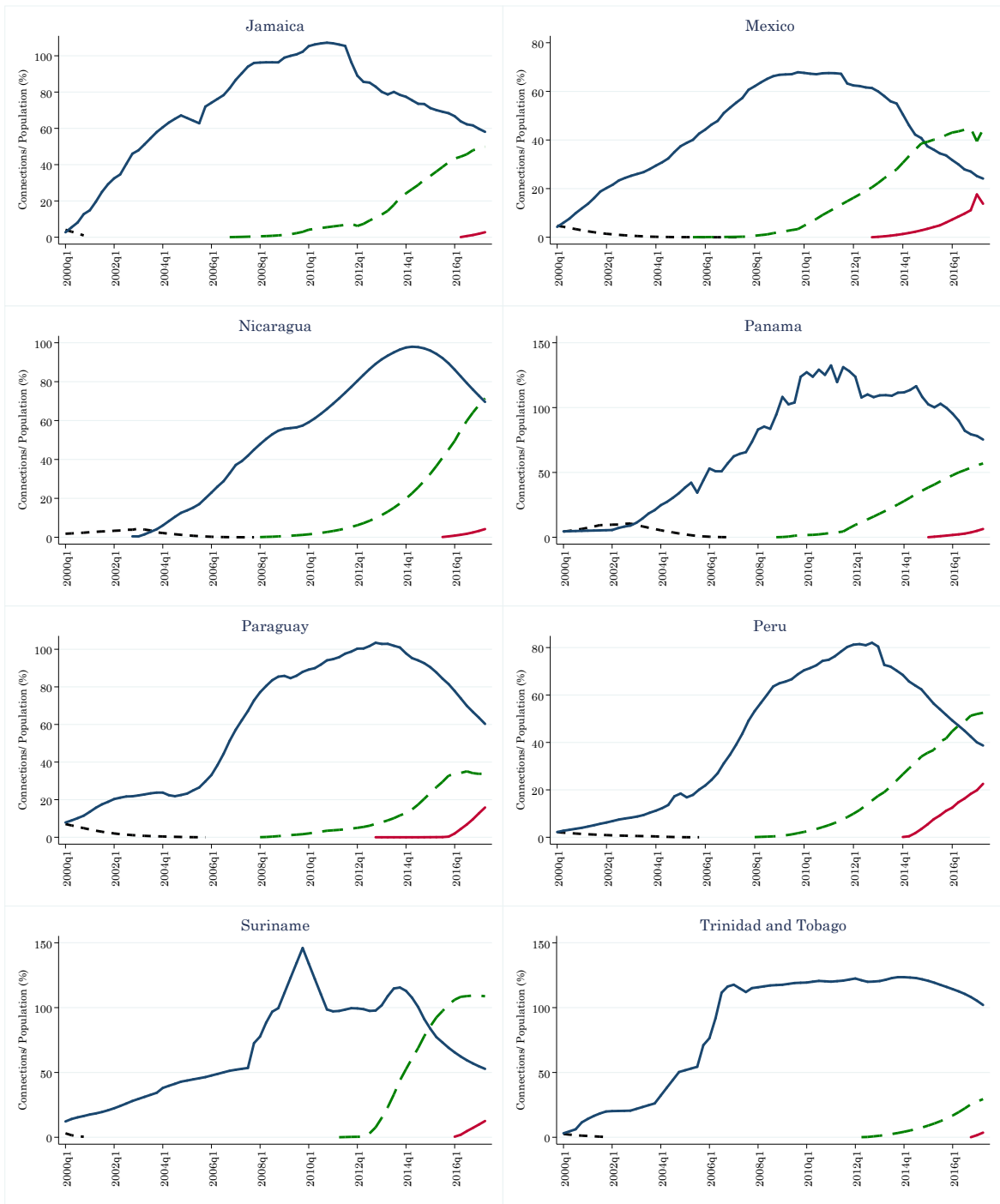


Figure A3. Existing Connections by Mobile Technology Generation and Country







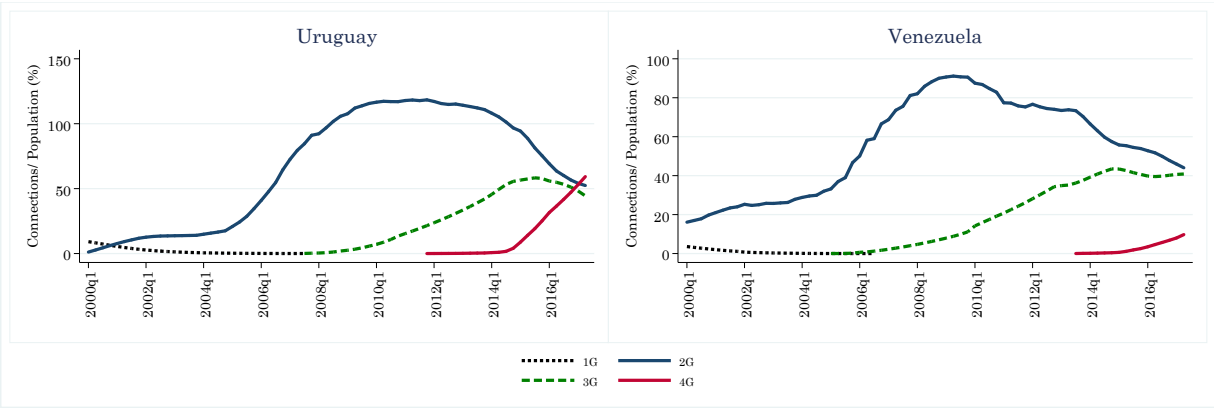
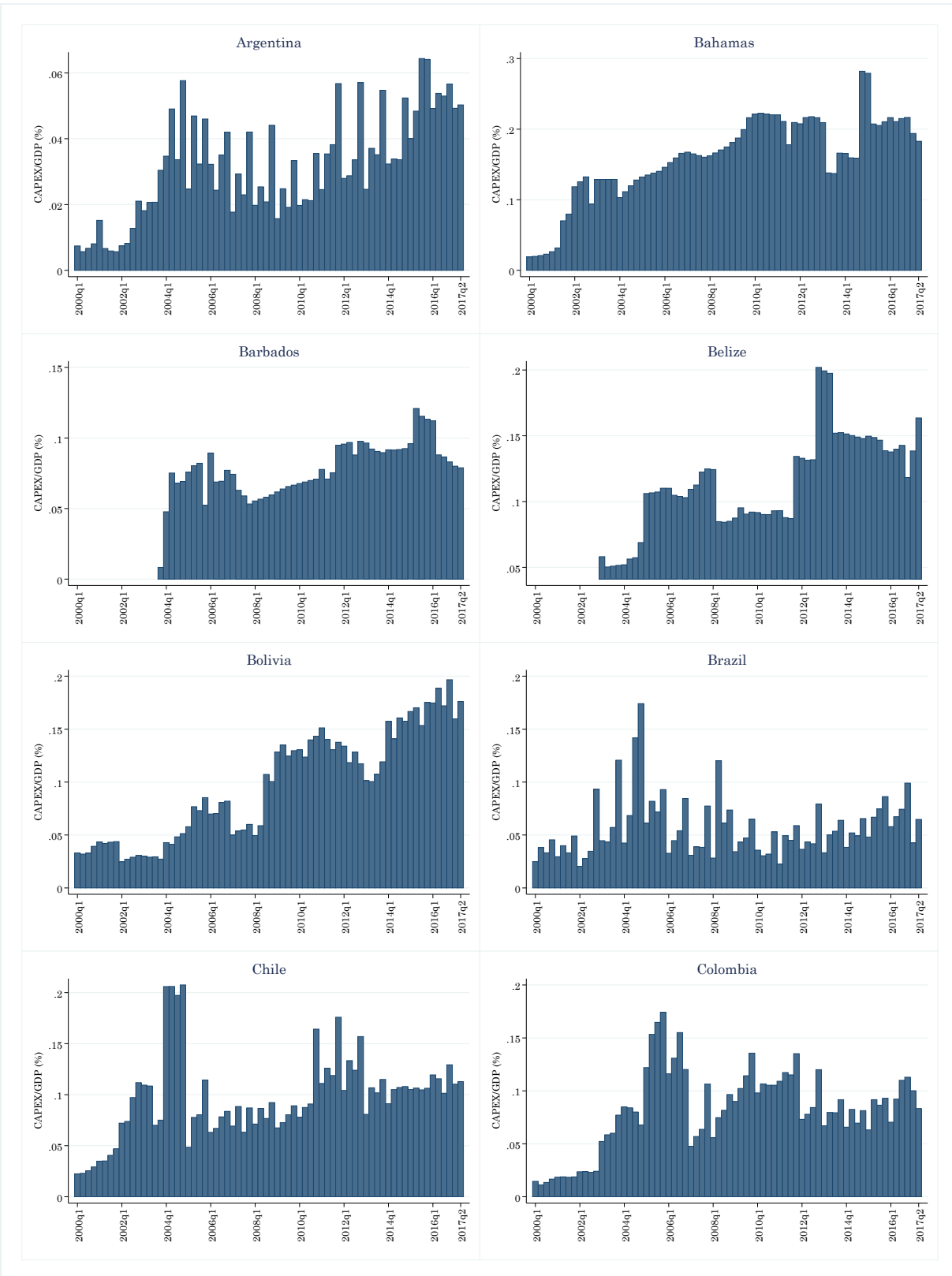
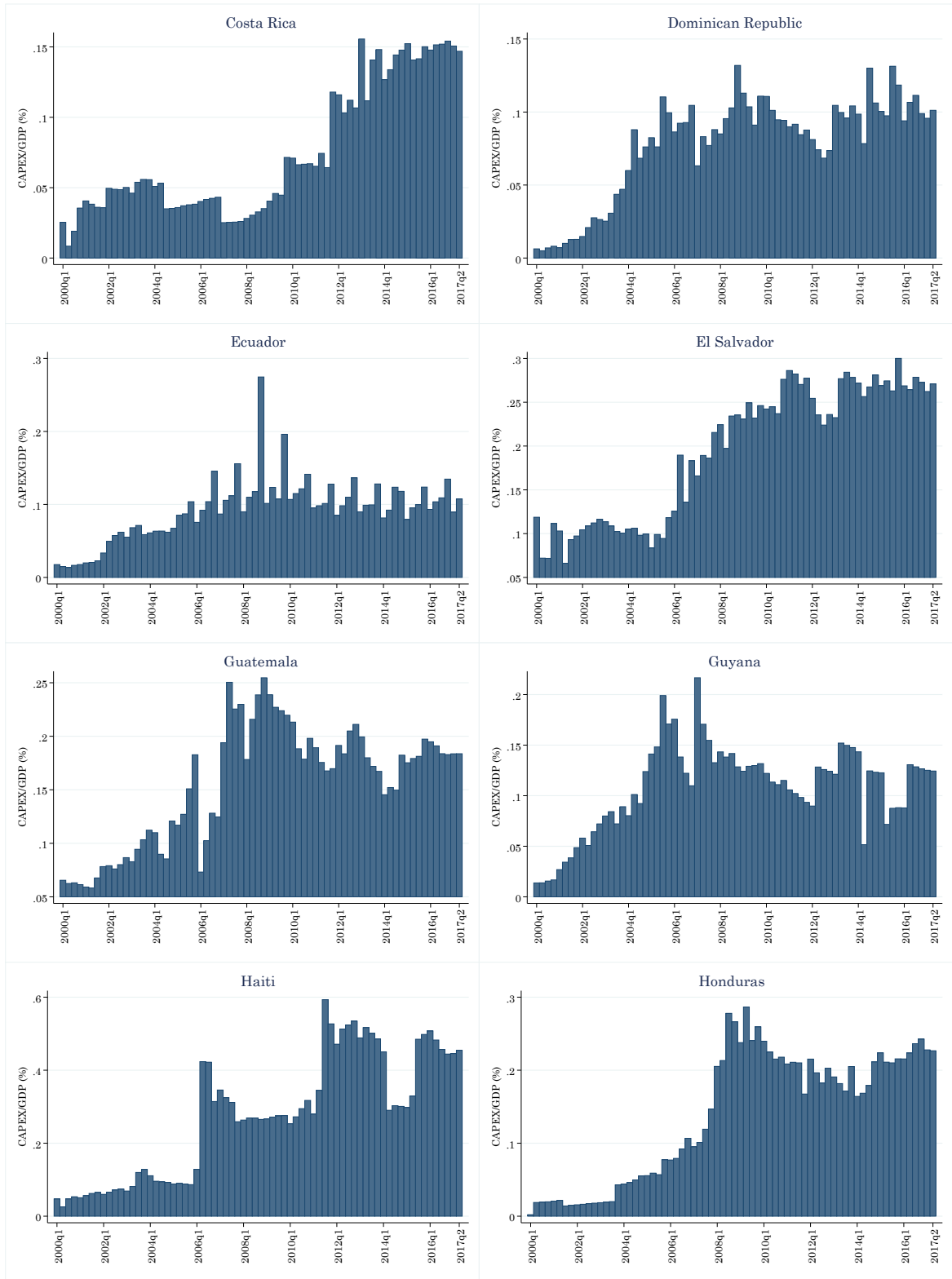


Figure A4. Quarterly Capital Expenditures over GDP by Country







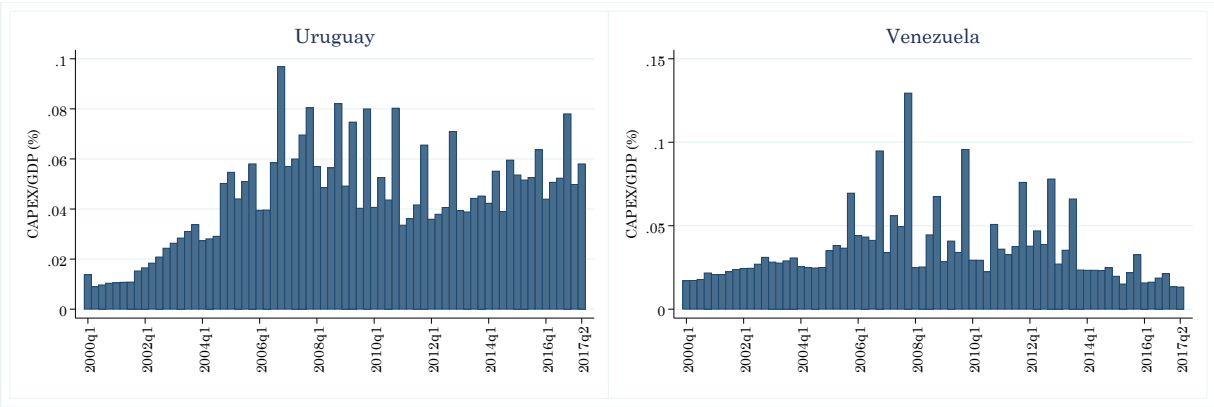
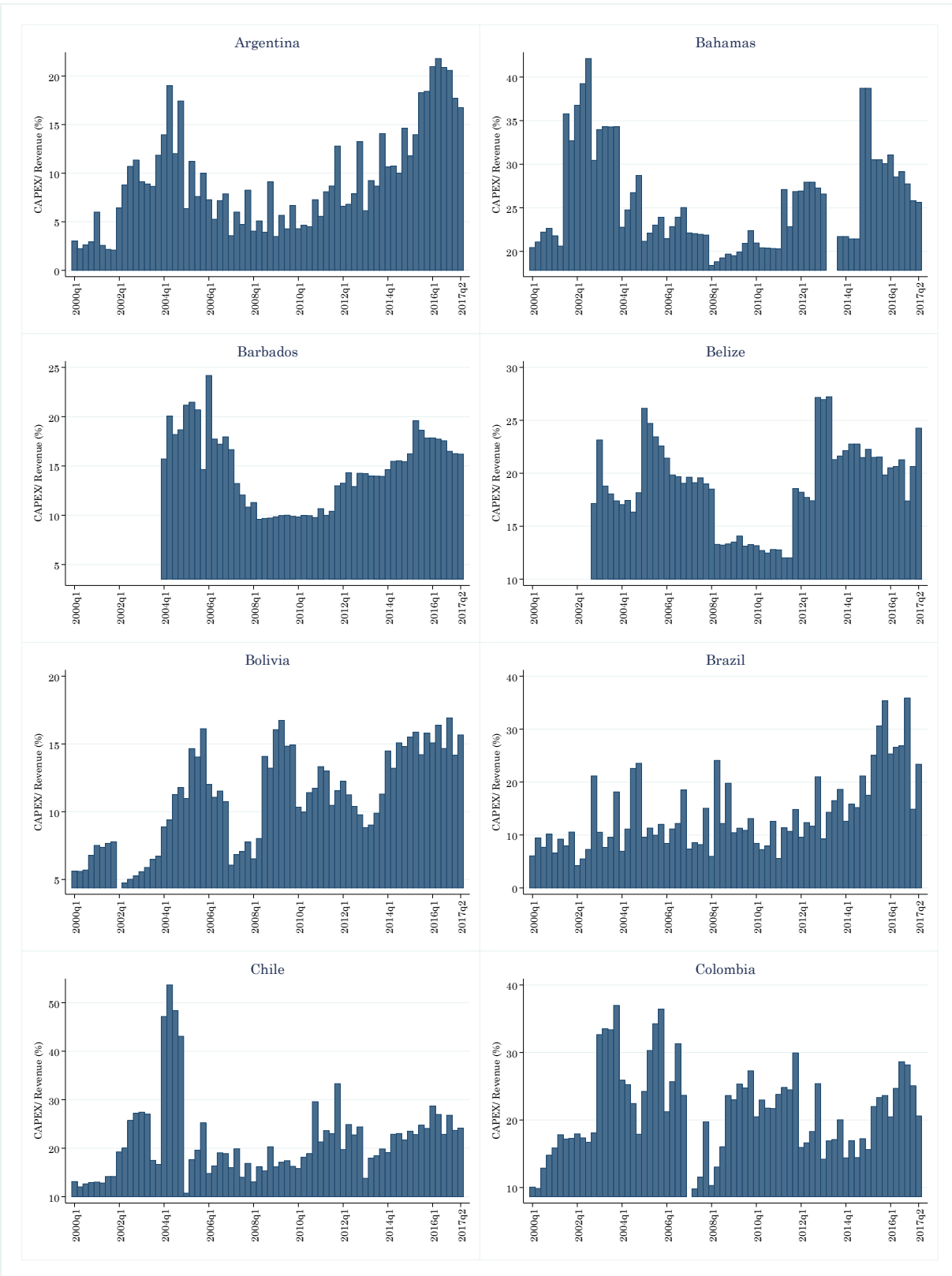
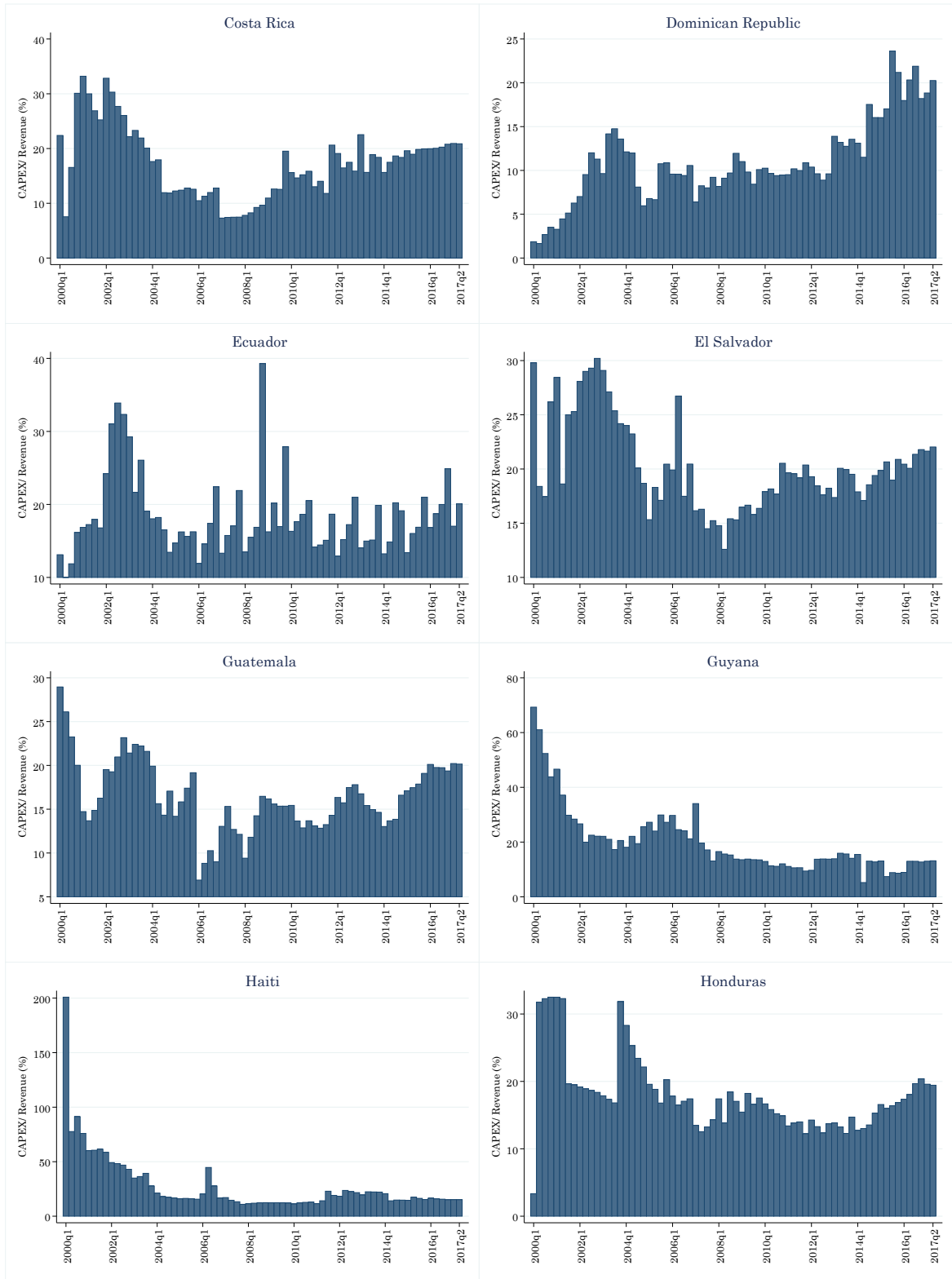
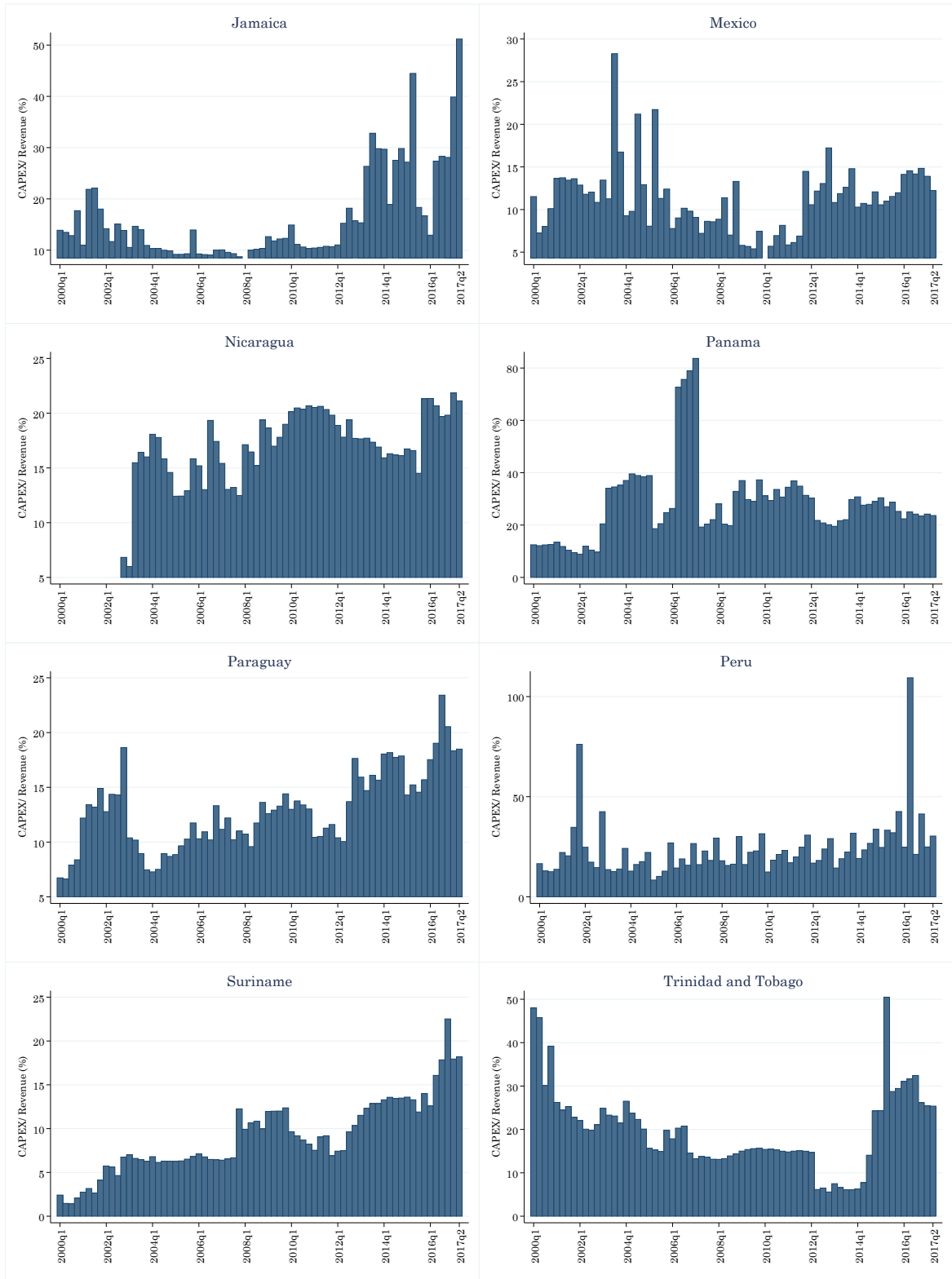


Figure A5. Quarterly Capital Expenditures over Revenue by Country (%)







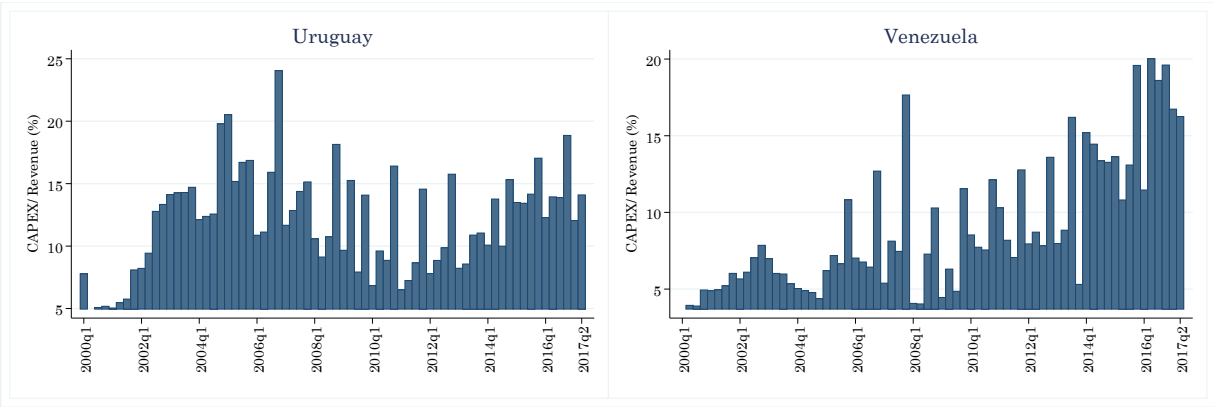


Figure A6. Quarterly Capital Expenditures per Existing Subscriber by Country

