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Regulation, Competition, and Market Power in Telecommunications across Latin America

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Abstract¹

This study examines the regulatory landscape and competitive dynamics in the telecommunications industry of five key Latin American countries: Colombia, Peru, Mexico, Brazil, and Chile. Focusing on market concentration analysis and the identification of regulatory policies that may impact market competitiveness, the research aims to contribute insights to the discussion about telecommunications policy in the region. This article encompasses the analysis for both fixed and mobile services for each country in the sample. Using descriptive analysis, I explore potential relationships among the evolution of key variables, offering evidence on the intricate interplay between regulation, competition, and market power in the Latin American telecommunications industry. Preliminary findings reveal a remarkable market concentration in mobile services and a somewhat lower yet significant concentration in fixed services. Quantitative reduced-form evidence supports expected impact of certain regulations on key market indicators across the region.

JEL classifications: L13, L43, L96

Keywords: Regulation, Competition, Market power, Mobile markets

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1 Introduction

Telecommunications plays a pivotal role in the economic landscape of Latin America. By the end of 2020, Peru's telecommunications services investment accounted for 0.65 percent of the GDP, with comparable figures of 0.55 percent for Colombia, 0.46 percent for Mexico, and 0.49 percent for Chile; Brazil invests at a higher level of 0.7 percent of GDP (World Bank Group, 2020). This firmly establishes the telecommunications sector as a crucial driver of economic growth throughout the region.

Beyond its substantial economic impact, the telecommunications industry in Latin America is intricately entwined with regulatory decisions. Among the enduring challenges faced by these markets, market concentration emerges as a notable concern. The implications of market concentration extend widely, impacting pricing, competition, and innovation. While concentration can result in efficiencies and economies of scale, it also raises concerns about potential competition erosion and market power exercise. In the telecommunications sector, the effects of market concentration stretch beyond corporate dynamics to directly affect consumers. This might lead to limited choices, diminished incentives for service innovation, and the potential for inflated prices in highly concentrated markets.

Several contributions provide evidence about the relationship between some market indicators and market power evidence in telecommunications markets. (Gutiérrez & Philippon, 2017), (Faccio & Zingales, 2018), (Bessen, 2016) and (Grullon, Larkin, & Michaely, 2017) highlight the importance of economic concentration and higher profitability of companies in the telecommunications sector, which generates higher profit margins and high returns on investment, leading to greater market power. This occurs due to the low restrictions on companies' ability to merge and acquire a larger share of the market, which limits competition. These dynamics are largely influenced by new political and economic reforms, as well as technological entry barriers.

This article aims to analyze the evolution of the telecommunications markets in Latin America, scrutinizing their behavior and exploring the implications for competition and regulatory oversight. The research seeks to provide comprehensive evidence on the evolution of both fixed and mobile telecommunications markets, using correlation analysis to unveil potential relationships among variables. A further analysis for Colombia uses a difference in difference causal analysis to provide insights about the impact mechanism of a particular regulatory decision.

The subsequent sections of the document are organized as follows: Section 2 provides the literature review, Section 3 describes the data and variables, Section 4 provides insights into the Latin America mobile telecommunications market, and the most relevant industry regulations. Section 5 presents the indicators' definitions; Section 6 describes the empirical strategy, and Section 7 presents the results. Section 8 summarizes the key findings and potential implications for future research and regulatory decisions. Section 9 concludes with a brief discussion.

2 Related Literature

The literature on the telecommunications sector in Latin America and the Caribbean provides valuable insights into the evolution of the market. A variety of studies collectively contribute to a comprehensive understanding of the telecommunications landscape in the region.

On the one hand, Montoya and Trillas (2007) explore the legal independence of Telecommunications Regulatory Agencies (TRAs) in Latin American countries over a 15-year period (1990–2004). They emphasize the crucial role of institutional design in shaping the effectiveness of regulatory policies. On the other hand, Hofman et al. (2016) investigate the impact of Information and Communication Technologies (ICT) on economic growth in Latin America. Their focus is on ICT investment and its role in explaining labor productivity and the GDP per capita divergence between Latin American countries and the United States. This analysis, conducted at both aggregate and sectoral levels, provides insights into the significance of ICT investment in the economic performance of the region.

Furthermore, Curwen and Whalley (2008) examine structural adjustments in the mobile telecommunications sectors of Latin America and Africa. Their exploration includes changes in ownership and the creation of new networks, offering insights into sector dynamics. The study identifies common patterns to assess whether the restructuring in both regions follows similar trajectories. In a related context, Aguilar et al. (2020) consider network effects in mobile telecommunications markets across five Latin American countries. Through empirical studies, they highlight positive network effects observed in technology diffusion. The study emphasizes the impact of network size on consumer preferences, considering individual-level data to assess how network effects influence consumers' choices regarding mobile operators.

These studies contribute to a comprehensive understanding of the telecommunications sector's evolution in Latin America and the Caribbean, covering topics from regulatory

independence to the role of ICT in economic growth, network effects in mobile markets, and structural adjustments in the mobile sector. In this work, we pursue the analysis key indicators such as average revenue per user (ARPU) and number portability operations, in addition to traditional indicators such as concentration and investment.

One relevant indicator for telecommunications markets is the rate at which subscribers drop out from the operator. This is measured as the ratio of the number of unsubscribed users to the total number of subscribers in the network. Typically, switching is driven by factors such as pricing, service quality (Mbarek & Baeshen, 2019), consumer satisfaction (García-Mariñoso & Suárez, 2019) and promotional offers (Miranda-Gumucio, Gil-Pechuán, & Palacios-Marqués, 2013).

In the telecom industry, even if companies attempt to strengthen their customer base while acquiring new clients, the magnitude of churn increases as the market becomes more mature. This is so given consumers can access more information and competition becomes more intense, (Capponi, Corrocher, & Zirulia, 2021). Higher churn causes a decrease in profit and makes a company lose a privileged position in the market, (Ascarza, 2018), (Gerpott, Rams, & Schindler, 2001), (Glady, Baesens, & Croux, 2009), (Reichheld & Sasser, 1990).

Several competition assessments consider a high churn conveys information about strong competition in the market. In the FCC proceeding 95-427, it was concluded that telecommunications consumers viewed AT&T's and its competitors' services to be very close substitutes. This conclusion, combined with the FCC's finding that AT&T and its rivals engaged in extensive advertising campaigns, indicated that AT&T lacked the ability to raise its price unilaterally above competitive levels for the residential long-distance market (Jamison, Berg, & Jiang, 2009).

In a similar vein to the fixed markets, in mobile markets, the FCC considers churn as an indicator of switching costs. "A reasonable proxy to determine whether switching costs are high enough to prevent consumers from making changes is churn. (...) By examining the magnitude and trend over time-of-service provider churn, we can quantify the degree to which consumers have both the desire and the ability to change service providers to better meet their mobile wireless service needs."

The main purpose of measuring churn is to establish if consumer switching costs are detrimental to competition. If churn rates are larger than zero, it indicates that some customers are not locked in, although consumers may still face costs when switching among firms, (FCC, 2010).

Some costs related to switching include concerns about arranging old and new services to stop and start at the same time, double charge for overlapping services over time, and time devoted to the switching process, among others (Chan, 2024).

However, low levels of churn might also indicate similar service characteristics among networks. In some markets, service quality is known to be rather equal across service providers. This is the case, for instance, in the Norwegian mobile telecommunications market. Thus, low churn rates are expected if service quality and satisfaction are the prime drivers of churn. When this is not the case it is reasonable to look for other determinants of churn (B. Svendsen & K. Prebensen, 2013).

Management decisions at the firm level seek to reach and sustain a leading position in the industry (Asimakopoulos & Whalley, 2017), (Ferrier, Smith, & Grimm, 1999). This is particularly relevant in industries such as telecommunications or energy, where network effects might lead to market leadership (Doganoglu & Grzybowski, 2007), (McIntyre & Subramaniam, 2009). It is also possible that first mover advantage leads to market leadership (Lieberman & Montgomery, 1998).

Pursuing a leading position requires investment on technology. The incentives to innovate bring two forces at work: on one hand, a large business in concentrated markets can seek greater returns on innovation to protect the competitive advantage associated with its innovation given its larger market share, so the incentive can be positive, i.e., incentive to innovate. On the other hand, a large firm might not want to innovate if it can earn substantial profits by protecting the status quo. Regarding the ability to innovate, a large business in oligopolistic markets is likely to have more working capital and the ability to combine complementary assets to invest in radical technological innovations, which require large-scale and comprehensive R&D (Lin, Lu, & Chen, 2018).

Telecommunications markets are prone to this type of countervailing incentives. From a theoretical perspective, there is not a conclusive relationship between investment and competition. (Sacco & Schmutzler, 2011) find a U-shaped relationship, whereas (Belleflamme & Vergari, 2011) predict an inverted-U shaped relationship. Given this dilemma, it is interesting to explore the relationship between competition and investment.

The telecommunications industry has witnessed significant transformations driven by technological advancements. Investments in new technologies have both been lauded for their potential to enhance competition and criticized for their potential to stifle it. Below, I explore the

positive and negative effects of technology investment on competition in telecommunications markets.

In regard to technology investment in competition, several contribution consider the number of subscribers per technology as the best proxy for technology innovation (Bauer & Shim, 2012), (Gruber & Koutroumpis, 2013), and (Bouckaert, Van Dijk, & Verboven, 2010).

3 Data

The data I use in this research include information from fixed and mobile operators in five Latin American countries: Colombia, Peru, Chile, Mexico, and Brazil. These countries were selected because of information availability, the similar behavior of the telecommunications market and the momentum of the different regulations in the sector. The information collected includes data on revenue, subscribers, investment, technology subscribers and number portability. It is important to note that the frequency of the data differed according to the reporting practices in each country. Some databases were broken down on a monthly, quarterly, or annual basis, providing a broad and detailed perspective for further analysis.

This rigorous data collection provides robustness and representativeness of information. The data were gathered either from open web site resources or through formal requests by email to the telecommunication industry's regulatory entities in each of these countries (see the regulatory bodies in Table 3). In addition, complementary data were searched and downloaded from the EMIS website² and from the financial statements available on the official website of each operating company. These financial data include information about operators' revenues, EBITDA and net profit, as well as household spending on telecommunications. These datasets are essential for the computation of key indicators that provide a comprehensive view of the development, competition and concentration dynamics of the telecommunications market.

Table 1 shows the details of the variables used in this report. These variables are classified according to their frequency (year or quarter), market (fixed or mobile) and operator. The complete availability of the data starts depending on the availability. In Chile and Brazil, we find information from 2010 onwards. In the case of Peru, it is one year later in 2011. Colombia follows in 2012 and finally in Mexico in 2013, and for all countries we have information up to 2023.

² EMIS is a source of information on global markets, where we had access to this information thanks to a paid subscription from EAFIT University.

Table 1. Available Variables

Country	Variable	Frequency	Per market (fixed/mobile)	Per operator
Colombia	Subscribers	Monthly	Yes	Yes
Colombia	Revenue	Quarter	Yes	Yes
Colombia	Investment	Quarter	Yes	Yes
Colombia	Number portability	Quarter	No	Yes
Colombia	EBITDA	Annual	No	Yes
Colombia	Net profits	Annual	No	Yes
Colombia	Subscribers per technology 2G, 3G, 4G and 5G	Quarter	Yes	Yes
Peru	Subscribers	Monthly	Yes	Yes
Peru	Revenue	Annual	Yes	Yes
Peru	Investment	Annual	Yes	Yes
Peru	Number portability	Monthly	Yes	Yes
Peru	EBITDA	Annual	No	Yes
Peru	Net profits	Annual	No	Yes
Peru	Subscribers per technology 2G, 3G, 4G and 5G	Quarter	No	No
Chile	Subscribers	Monthly	Yes	Yes
Chile	Revenue	Not available		
Chile	Investment	Not available		
Chile	Number portability	Annual	Yes	Yes
Chile	EBITDA	Annual	No	Yes
Chile	Net profits	Annual	No	Yes
Chile	Subscribers per technology 2G, 3G, 4G and 5G	Quarter	No	No
Mexico	Subscribers	Monthly	Yes	Yes
Mexico	Revenue	Quarter	Yes	Yes
Mexico	Investment	Annual	Yes	Yes
Mexico	Number portability	Quarter	Yes	Yes
Mexico	EBITDA	Annual	No	Yes
Mexico	Net profits	Annual	No	Yes
Mexico	Subscribers per technology 2G, 3G, 4G and 5G	Not available		
Brazil	Subscribers	Monthly	Yes	Yes
Brazil	Revenue	Not available		
Brazil	Investment	Not available		
Brazil	Number portability	Monthly	Yes	Yes
Brazil	EBITDA	Annual	No	Yes
Brazil	Net profits	Annual	No	Yes
Brazil	Subscribers per technology 2G, 3G, 4G and 5G	Quarter	No	No

The calculation of relevant metrics, such as the Herfindahl-Hirschman Index (HHI), average revenue per user (ARPU), and churn, has been instrumental in providing a nuanced understanding of market competitiveness and efficiency. The Herfindahl-Hirschman Index (HHI) functions as a quantitative measure of market concentration, revealing the competitive structure prevailing in each country. Simultaneously, the computation of average revenue per user (ARPU) provides nuanced perspectives on market efficiency. ARPU sheds light on the revenues of telecom operators. These indicators bear significant relevance, serving as tools for identifying and

comprehending the dynamics of the telecommunications market. They lay a robust foundation for evaluating the overall performance of the market, pinpointing potential areas for improvement, and supporting informed decision-making within both regulatory and business realms.

Table 2. Variables to be Analyzed

Variable name	Description
ARPU	Quarterly and yearly average revenue per user is computed separately for mobile services and fixed services
HHI	Quarterly and yearly Herfindahl-Hirschman Index. It is calculated separately for revenues and subscribers for both mobile and fixed services.
Market share	Quarterly and yearly market share per operator is computed separately for mobile services and fixed services
Churn	Quarterly and yearly Number of Subscriber Portability/Totally of Subscribers
Net profit to Revenue ratio	Quarterly and yearly Total Net profit /Total market Revenue
EBITDA to Revenue ratio	Quarterly and yearly Total EBITDA/Total market Revenue
Investment to Revenue ratio	Quarterly and yearly Total Investment/Total market Revenue
Technology subscribers	Yearly Subscribers per technology/Totally subscribers
Household expenditure on telecommunication	Quarterly and yearly Household Telecommunication Expense/ Household Expenditure

4 Latin America Mobile Telecommunications Market

Several Latin American countries have implemented a variety of regulatory decisions in the last decade. This study focuses on analyzing how these regulations have been adopted at different times and contexts within each country and evaluating their possible impact. To this end, I carried out a thorough search including formal requests to the relevant regulatory entities, as well as the review of the official pages of those entities. Table 3 lists the regulatory bodies that provided the relevant information in each country.

Table 3. Regulatory Bodies

Country	Telecommunications Regulatory Bodies	Acronym
Colombia	Comisión de Regulación de Comunicaciones	CRC
Chile	Subsecretaría de Telecomunicaciones	SUBTEL
Brazil	Agência Nacional de Telecomunicações	ANATEL
Mexico	Instituto Federal de Telecomunicaciones	IFT
Peru	Organismo Supervisor de Inversión Privada en Telecomunicaciones	OSIPTEL
Costa Rica	Superintendencia de Telecomunicaciones	SUTEL
El Salvador	Superintendencia General de Electricidad y Telecomunicaciones	SIGET
Dominican Republic	Instituto Dominicano de las telecomunicaciones	INDOTEL
Argentina	Ente Nacional de Comunicaciones	ENACOM
Ecuador	Agencia de Regulación y Control de las Telecomunicaciones	ARCOTEL
Paraguay	Comisión Nacional de Telecomunicaciones	CONATEL
Honduras	Comisión Nacional de Telecomunicaciones	CONATEL
Bolivia	Autoridad de Regulación y Fiscalización de Telecomunicaciones y Transportes	ATT
Uruguay	Unidad Reguladora de Servicios de Comunicaciones	URSEC
Guatemala	Superintendencia de Telecomunicaciones	SIT
Venezuela	Comisión Nacional de Telecomunicaciones de Venezuela	CONATEL
Cuba	Ministerio de Comunicaciones	MIC
Panama	Autoridad Nacional de los Servicios Públicos	ASEP
Puerto Rico	Junta Reglamentadora de Telecomunicaciones de Puerto Rico	JRTPR

The primary objective of this section is to identify relevant regulations in the telecommunications sector. To achieve this, we searched for and analyzed all the relevant regulations implemented in Latin American countries over the years. Areas of regulation include the following:

1. Implementation of number portability.
2. Application of mobile phone compatibility with all mobile networks.
3. Regulation of retail rates, such as On-net call prices vs. Off-net call prices (if applicable).
4. Prohibition of minimum permanence clauses – Early Termination Fee (ETF).
5. Implementation of national Automatic Roaming between operators.
6. Indicator on the existence of rate regulation for sharing passive infrastructure, such as poles, ducts, towers, cameras.

7. Indicator on the existence of rate regulation for sharing active infrastructure, such as antennas.

The purpose of the telecommunications regulations is to ensure that the sector operates efficiently, benefiting both consumers and service providers. One such regulation is the implementation of number portability, enabling consumers to keep their phone numbers even when they change service operators. This regulation encourages competition between companies, but it also promotes operational efficiency within the industry, improving service quality and technology (Roberts M, 2020).

Likewise, cell phone compatibility refers to the ability of a mobile handset to work properly with any operator available in the market. In economic terms, this regulation was implemented to reduce switching costs, thus prioritizing consumer choice and encouraging flexibility in the use of their devices on any network (Ministerio De Transportes y Telecomunicaciones; Subsecretaría De Telecomunicaciones, 2013).

There is another regulation known as retail tariff regulation. This sets the prices paid by consumers for services. This regulation is designed to boost free competition and foster new technologies, while also enabling firms to recover the costs of providing services. Additionally, it aims to rectify market failures where there are insufficient conditions for competition (Comisión de Regulación de Comunicaciones, 2022).

The minimum permanence clauses (also known as early termination fees), requires consumers to remain subscribed with the same operator for a specified period of time. This contractual toll was forbidden in several countries to give consumers the choice of operator service and to avoid paying penalties. This regulation removes artificial barriers to operator switching and increases competition in the industry (Comisión de Regulación de Comunicaciones, 2016).

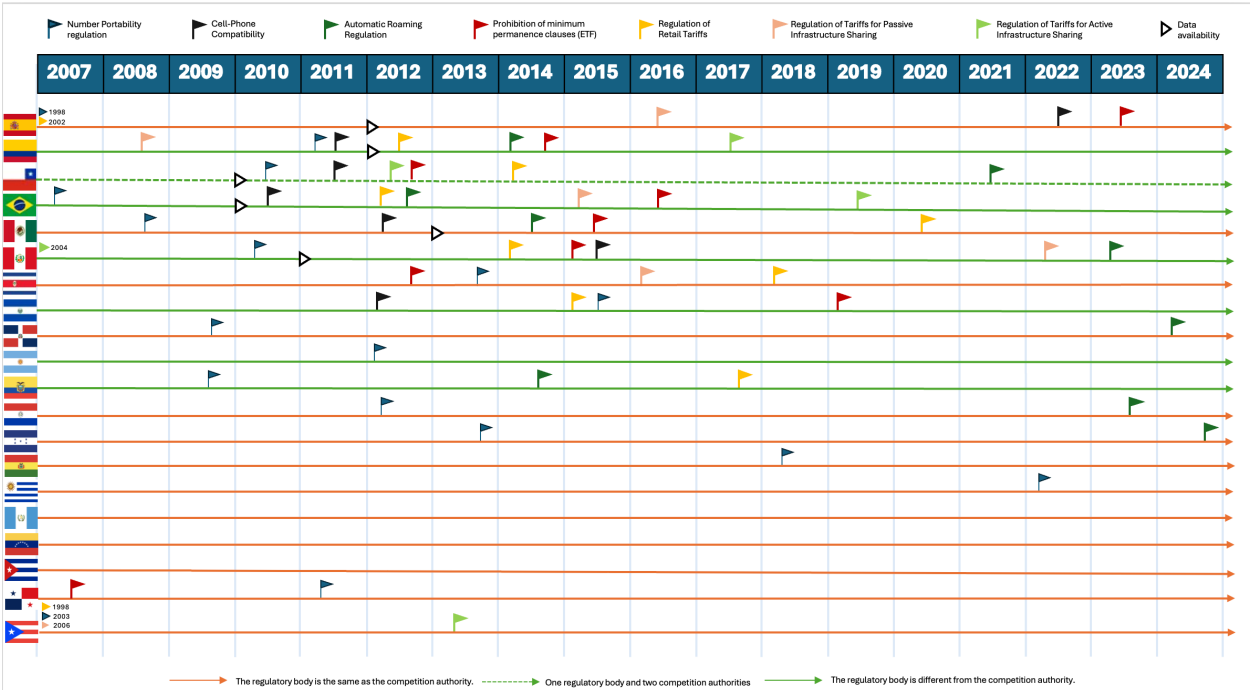
More recent regulation addresses national roaming. This regulation allows users to continue enjoying the service of their operator in a different mobile network when they are outside their home operator's coverage area. This regulation arose with the purpose of closing the digital divide and increasing connectivity between people regardless of geographical boundaries (Feria, 2015).

In this context, the regulation of tariffs for the shared use of passive and active infrastructures aims to achieve several objectives. First, it aims to expand the coverage of telecommunications services in the countries, as stated in (Plataforma del Estado Peruano, 2023)

and (Comisión de Regulación de Telecomunicaciones, 2008). It also aims to promote efficient infrastructure rollout and reach areas where connectivity was previously lacking. Second, it addresses the problem of duplication of costs by allowing several operators to share the same infrastructure, without having to pay costs related with its implementation, installation and maintenance as mentioned in (Ministerio de Transportes y Telecomunicaciones Chile, 2024). In essence, this regulation encourages transparent competition between active operators and new entrants, as barriers to entry have been lowered, thus benefiting users, who will be able to choose the best option among all operators as explained by (Portal Único del Estado Colombiano, 2020).

In addition to the regulations implemented, it should be noted that the launch of 3G, 4G and 5G technologies are strategies to expand mobile connectivity across regions, increase coverage and modernize telecommunications services, thus meeting the demand for new technologies in the world, as mentioned in (Agência Nacional de Telecomunicações (ANATEL), 2020) and (Ministerio de Tecnologías de la Información y las Comunicaciones, 2022).

Figure 1. Relevant Regulations in Latin America



Source: Author’s compilation.

As shown in Figure 1, the adoption of the early termination fees (ETF) occurred almost simultaneously in several countries. Panama was the pioneer, implementing this decision in 2007, while Spain did so far later, in 2023. Regarding the introduction of 4G technology, most countries adopted it in 2014, with exceptions such as Spain and Brazil in 2013 and Mexico and Dominican Republic in 2012. In contrast, El Salvador and Cuba adopted this technology years later. Another relevant aspect is the retail regulation of on-net and off-net prices in the telecommunications sector, which was implemented in a more dispersed manner at different times in different countries.

It is important to note that Cuba has not implemented most of these regulations, except for the launch date of 3G and 4G technologies. This is because in Cuba, unlike other countries, there is a single public operator for both fixed and mobile telephony, which represents a monopoly. Furthermore, the sharing of active infrastructure is not allowed in the country.

5 Indicators Analysis

5.1 *ARPU*

The average revenue per user (ARPU) is a key financial indicator used in various industries, especially telecommunications, subscription services, and mobile applications. This indicator provides information on how much money is collected by the firm from each consumer. ARPU is calculated by dividing the total revenue generated by the company in a specific period, usually quarterly or annually, by the total number of active users during that same period.

$$ARPU = \frac{\text{Total Revenue per Firm}}{\text{Number of Subscribers per Firm}}$$

5.2 *Churn*

Churn, also known as churn rate or customer churn rate, is a fundamental indicator used in various industries, especially telecommunications, subscription services and technology, to measure customer loss in a specific period.

Churn is calculated by dividing the number of customers who canceled their subscription or stopped using a service during a given period by the total number of customers at the beginning of the period and multiplying the result by 100 to obtain a percentage.

$$CHURN = \frac{\text{Number of Subscriber Portability}}{\text{Totally of Subscribers}}$$

This indicator is essential for businesses because it helps understand and manage customer retention, which is crucial for long-term growth and profitability. High churn can be detrimental to a business as it means it is losing customers at a rapid rate, which can result in decreased revenue and damage brand reputation, as mentioned (Mbarek & Baeshen, 2019) in his research.

5.3 Market Share

This formula calculates the proportion of subscribers that a specific company has in relation to the total subscribers in each market, in this case in the fixed and mobile telecommunications market.

$$\text{Market Share} = \frac{\text{Total subscribers of a company}}{\text{Total subscribers in the market}}$$

Subscriber market share is a crucial indicator in several sectors, especially telecommunications. It provides a clear and concise measure of a company's or provider's share of a specific market in terms of number of subscribers. This indicator is vital to evaluate the competitiveness and relative success of companies in each market.

By analyzing subscriber market share, companies can gain a deep understanding of their market position compared to their competitors. A higher market share usually indicates greater market penetration and a stronger position in relation to competitors. Additionally, market share can be an important indicator of a company's financial performance and future growth potential.

5.4 HHI

The Herfindahl-Hirschman Index (HHI) is a measure used to assess market concentration in each industry. It is particularly useful in sectors where competition is important and can have significant implications for economic efficiency and consumer well-being.

The HHI is calculated by summing the squares of the market shares of all firms operating in the relevant market. Market shares are expressed as percentages and can be based on different metrics, such as market share in terms of subscribers or in terms of revenue.

Where in the telecom market, the subscriber-based HHI would be calculated by summing the squares of the market shares of each telecom service provider based on the total number of

subscribers in that market. Similarly, the revenue based HHI would be calculated using the market shares of each supplier based on the total revenue generated in the market.

$$HHI = \sum_{i=1}^n S_i^2$$

In summary, the Herfindahl-Hirschman Index (HHI) is an important tool for assessing the structure of competition in each market, whether in terms of subscribers or revenue. Its calculation and analysis provide valuable information for regulators, companies, and analysts in evaluating the competitive dynamics and level of concentration in a specific industry.

5.5 Technology Subscribers

This indicator provides a revealing view on the adoption of technology in various Latin American countries by measuring the number of subscribers in each of them. The formula is:

$$\text{Subscribers technology} = \frac{\text{Subscribers per technology}}{\text{Total number of Subscribers}}$$

5.6 Net Profit to Revenue Ratio

The net profit to revenue ratio is an important financial measure used in various sectors, including telecommunications. This indicator provides a view of a company's profitability by comparing its net profits (that is, profits after all expenses, taxes, and other costs) with its total revenues. In the context of telecommunications, this indicator can be especially relevant to evaluate the operational efficiency and profitability of companies that offer communication services, such as mobile telephony, internet services, cable television, among others. The formula is the following:

$$\text{Net profit to Revenue} = \frac{\text{Total net profit of company}}{\text{Total market revenue}}$$

5.7 EBITDA to Revenue Ratio

The EBITDA to revenue ratio is a measure used in telecommunications, for analyzing the profitability of a firm (that is earnings before interest, taxes, depreciation and amortization) compared to its total revenues. This indicator is relevant in telecommunications sector because

these companies invest in assets that quickly depreciate, such as network equipment. This is the formula:

$$EBITDA \text{ to Revenue} = \frac{EBITDA}{Total \text{ market revenue}}$$

5.8 Investment to Revenue Ratio

The investment to revenue ratio in telecommunication is the measure that indicates the expenditure related to property, plant, modernizing and developing the network, compared with the company's total revenues, as shown in the following formula:

$$Investment \text{ to Revenue} = \frac{Total \text{ Investment}}{Total \text{ market revenue}}$$

5.9 Household Expenditure on Telecommunication

This measure indicates total household spending on communications: the main expenditures are on fixed and mobile voice and data services, as a percentage of total household spending. plant, modernizing and developing the network. comparing with the companies' total revenues. This measure is determined by the following formula:

$$\begin{aligned} & \text{Household expenditure telecommunication to household expenditure} \\ &= \frac{\text{Household Telecommunication Expense}}{\text{Household Expenditure}} \end{aligned}$$

5.10 Information Collection

To obtain the data necessary to calculate these indicators, I use several information sources. First, the financial statements of each operating company nationwide were collected, downloading them from their respective websites. These financial statements provided net profits, EBITDA, investment, and annual revenue. In addition, the EMIS platform was used to access the financial statements of those companies that did not have this information available on their official websites. All these data were compiled into a single spreadsheet per country and then the formulas mentioned above was applied to calculate the indicators.

6 Empirical Strategy

The available data comprise information on the indicators described in Section 5. The information gathered covers these countries: Brazil, Colombia, Chile, Peru and Mexico.³ The main purpose of the analysis is to establish if regulations across the different countries lead to significant changes in competition indicators. The first component of the analysis is

$$indicator_{jt} = \alpha + \beta_1 regulation_{jt} + \gamma controls_t + \delta_j + \delta_t + \varepsilon_{jt}$$

where j and t represent country (operator, if available) and time, respectively. The variable $indicator_{it}$ represents country or firm-level indicators such as HHI revenue, churn, EBITDA to revenue ratio, investment to revenue ratio, household telecommunication expense to total household expenditure ratio, or investment to revenue ratio. The variable $regulation_{jt}$ is a dummy that accounts for the presence of a given regulation in country j at time t . I use the following regulations: Prohibition of minimum permanence clauses (ETF), cell-phone compatibility regulation, automatic roaming regulation and number portability regulation. $controls_{jt}$ is a control variable that accounts for GDP per capita. Finally, δ_j and δ_t control for country, operator, if available, and time fixed effects.

If the data allow us to do so, we can still explore the effect of a given regulation inside a country. For the case of Colombia, we have gathered detailed data on mobile and fixed services, divided between Internet and voice offers. These fine-grained data allow us to propose an identification strategy that considers the fixed market as the control group and mobile market as the treatment group. In such a scenario, the empirical strategy follows:

$$ARPU_{jt} = \alpha + \beta_1 Regulation_ETF_t + \beta_2 Treated_Colombia_j + \beta_1 Regulation_ETF_t * Treated_Colombia_j + \eta + \varepsilon_{jt}$$

In this case. The variable $ARPU_{jt}$ represents the average revenue per user. $Regulation_ETF_t$ is a dummy that indicates when the prohibition of minimum permanence

³ Besides listed countries with public data available, I also performed several requests to gather data from Cuba, Honduras, Ecuador, Venezuela, Nicaragua, Paraguay, and Panama. However, it was not possible to obtain relevant information. Other countries for which data were searched for and requested: Uruguay, Argentina, Bolivia, Costa Rica, and Dominican Republic. Data for these countries, however, are scarce or incomplete.

clauses at time t , is active. $Treated_Colombia_j$ is a dummy variable that indicates mobile market as the treatment group. Finally, η are fixed effects, and ε_{jt} is the error term.

7 Results

Several authors, such as (Genakos, Valletti, & Verboven, Evaluating market consolidation in mobile communications., 2018), (Brunnermeier, Limodio, & Spadavecchia, 2023), (Bahia & Castells, 2023) and (Houngbonon, Ivaldi, Palikot, & Strusani, 2023) use Gross Domestic Product (GDP) as a control variable in their studies, indicating that GDP per capita is a strong control variable for this study. Therefore, as we run each model, we find how the regulations affect the abovementioned indicators including time, operator and country fixed effects, in addition to GDP per capita as the control variable.

7.1 ETF Regulation

Table 4 shows the regressions related to prohibition of minimum permanence clauses. These results show that the regulation of ETFs has diverse effects on the indicators of the telecommunications sector. In a first approach, it is observed that regulation reduces the mobile HHI index of the companies by 927.8. It also reduces companies' EBITDA by 0.0978 percentage points on average. Investment has the opposite effect, where regulation increases by 0.276 percentages points on average, but reduces the result of the interaction between regulation and the mobile HHI of subscribers. Similarly, regulation is associated with a 0.00613 reduction in percentage points as an average proportion of telecommunication expense in the sector. In most cases, GDP per capita has a positive effect.

Table 4. ETF Regulation

	(1)	(2)	(3)	(4)	(5)
	Mobile HHI	EBITDA/Revenue	EBITDA/Revenue	Investment/Revenue	Telecom Expense/Expenditure
Mobile ETF Regulation	-927.8*** (284.7)	0.0215 (0.0330)	-0.0978*** (0.0346)	0.276*** (0.0700)	-0.00613** (0.00230)
GDP per capita	-0.531 (0.300)	0.0000255*** (0.00000453)	-0.0000125 (0.00000904)	0.0000151 (0.0000110)	-0.00000604 (0.00000817)
Mobile ETF Regulation * Mobile HHI Subscribers				-0.0000293*** (0.0000113)	
Constant	8024.2*** (1950.6)	0.0305 (0.0471)	0.425*** (0.0907)	0.124 (0.114)	0.0566*** (0.00892)
Controls					
Year - Quarter	No	Yes	Yes	Yes	No
Country	Yes	No	Yes	Yes	Yes
Network	No	Yes	No	Yes	No
Number of observations	14	204	834	1365	60
R-squared	0.920	0.889	0.355	0.895	0.859

Source: Author's compilation.

Note: Coefficients explain the effect of the ETF regulation on the different indicators: Mobile HHI, EBITDA to revenue ratio, Investment to revenue ratio and Telecommunication expense of household to expenditure ratio. * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

n.a. = not applicable

7.2 Cell-phone Compatibility Regulation

Table 5 shows the regressions related to cell-phone compatibility regulation. In the case of the regulation of cell phone compatibility, this has a negative impact on all the indicators analyzed. In the case of EBITDA, this reduction is 0.144 percentage points on average, investment is reduced by 0.0971 percentage points on average, and the mobile HHI index is similarly reduced by 1112.2, reflecting low operating profitability and lower concentration in the telecommunications market. In this case, GDP per capita only has a significant effect when the ratio of investment to income is revised, but the effect is still low.

Table 5. Cell-phone Compatibility Regulation

	(1)	(2)	(2)
	EBITDA/Revenue	Investment/Revenue	Mobile HHI
Cell-phone compatibility Regulation	-0.144*** (0.0408)	-0.0971*** (0.0253)	-1112.2** (400.5)
GDP per capita	0.0000109 (0.0000111)	0.0000820*** (0.00000886)	0.0470 (0.164)
Constant	0.246*** (0.0921)	-0.355*** (0.0886)	4430.6*** (1526.0)
Controls			
Year - Quarter	Yes	Yes	Yes
Country	Yes	Yes	Yes
Network	No	Yes	No
Number of observations	834	1465	41
R-squared	0.358	0.881	0.890

Source: Author's compilation.

Note: Coefficients explain the effect of the Cell-Phone Compatibility Regulation on the different indicators: EBITDA to revenue ratio, Investment to revenue ratio and Mobile HHI. * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

n.a. = not applicable

7.3 Automatic Roaming Regulation

Table 6 shows the regressions related to automatic roaming regulation. This regulation increases Mobile Churn by 0.00219 and increases the HHI index by 810.4, suggesting an increase in the rotation of clients among operators and a greater market concentration. On the other hand, household expenditures on telecommunications as an average proportion of telecommunication expense are reduced by 0.0102 percentage points. GDP per capita only has a significant negative effect on mobile churn, but that effect is still small.

Table 6. Automatic Roaming Regulation

	(1)	(2)	(3)
	Mobile Churn	Mobile HHI	Telecom Expense/Expenditure
Automatic Roaming Regulation	0.00219*** (0.000710)	810.4*** (169.2)	-0.0102*** (0.00200)
GDP per capita	-0.000000601*** (0.000000229)	-0.0462 (0.0716)	-0.000000156 (0.000000632)
Constant	0.0267*** (0.00246)	4241.3*** (705.0)	0.0532*** (0.00646)
Controls			
Year - Quarter	Yes	Yes	No
Country	Yes	Yes	Yes
Number of observations	3871	164	60
R-squared	0.469	0.897	0.893

Source: Author's compilation.

Note: Coefficients explain the effect of the Automatic Roaming Regulation on the different indicators: Mobile Churn, Mobile HHI and Telecommunication Expense of Household to Expenditure ratio. * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

n.a. = not applicable

7.4 Number Portability Regulation

Table 7 shows the regressions related to number portability regulation. It is evident that this regulation does not have a significant impact on the moving HHI index. It does, however, have a positive effect on the investment to revenue ratio of 0.235, but when making the interaction between the regulation and the HHI index of subscribers it is reduced by 0.0000303, which could suggest that the investment capacity is being limited. In this case, GDP per capita only has a negative effect of 0.195 when analyzed with the moving HHI index.

Table 7. Number Portability Regulation

	(1)	(2)
	Mobile HHI	Investment/Revenue
Number Portability Regulation	-45.42 (514.6)	0.235*** (0.0693)
GDP per capita	-0.195* (0.112)	0.0000114 (0.0000109)
Number Portability Regulation * Mobile HHI Subscribers		-0.0000303** (0.0000122)
Constant	5815.6*** 656.7	0.173* (0.105)
Controls		
Year - Quarter	No	Yes
Country	Yes	Yes
Network	No	Yes
Number of observations	59	1365
R-squared	0.567	0.895

Source: Author's compilation.

Note: Coefficients explain the effect of the Number Portability Regulation on the different indicators: Mobile HHI and Investment to Revenue ratio. * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance. n.a. = not applicable

7.5 Colombia DiD

Table 8 shows the results of this regression. The interaction between the regulation and the mobile operator reduces ARPU by COP \$21,921 in the voice service of Colombia, compared to the control group. The opposite is the case for internet service, where there is no significant effect of this regulation.

Table 8. Colombia DiD

	ARPU	
	Voice (1)	Data (2)
ETF Regulation * Treated Colombia (1 = Mobile)	-21920.7* (11527.7)	-312286.9 (490692.3)
ETF Regulation	385.1 (9113.9)	314733.1 (491296.0)
Treated Colombia (1 = Mobile)	-12139.6 (13762.7)	145244.4 (456785.6)
Constant	77264.6*** (6188.2)	467778.3 (387390.1)
Controls		
Network	Yes	Yes
Number of observations	1291	1071
R-squared	0.286	0.759

Source: Author's compilation.

Note: Coefficients explain the effect of the ETF Regulation on ARPU. * Coefficient is statistically significant at the 10 percent level; ** at the 5 percent level; *** at the 1 percent level; no asterisk means the coefficient is not different from zero with statistical significance.

n.a. = not applicable

8 Conclusions

The regulations had different impacts on the telecommunications sector. In the first instance, the prohibition of minimum permanence clauses is associated with a reduction in market concentration, profits, and the percentage of household spending on telecommunications services. It is also associated with an increase in firm investment. This regulation is the one that influences the largest number of indicators. Another important regulation, cell-phone compatibility regulation, is associated with a reduction in profit, investment and market concentration of the companies in the sector.

Regarding automatic roaming regulation, it is associated with an increase in market concentration, and an increase in the churn rate—i.e., with this regulation, consumers are more likely to switch service providers more often. On the other hand, this regulation is associated with a reduction in the percentage of household spending on telecommunications services. This means that automatic roaming is associated with lower expenditure in telecommunications services. When considering number portability regulation, it is evident that the regulation does not have a

significant impact on market concentration, when considering GDP per capita. On the contrary, it is associated with an increase in investment.

In the case of in-country regulation, we show that in Colombia there is causal evidence in the telecommunications sector of price reductions for voice services because of the regulation of permanence clauses, but no considerable effect on internet services.

9 Discussion

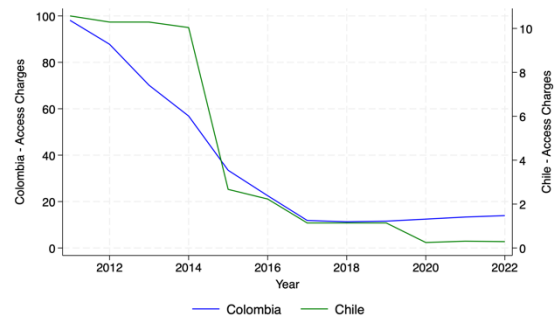
A possible important debate involves how some regulatory changes may have economic outcomes other than those discussed above. (Cave & Mariscal, 2020) noted that the telecommunications reform in Mexico imposed on operators with asymmetric tariffs led to zero rates in mobile interconnection. This had an impact on the entire population, allowing sectors with low connectivity to now enjoy this type of services in a more significant way. This was a distributional impact, as access to telecommunications services was biased towards high-income consumers.

It is also necessary to discuss possible benefits of improved connectivity, which do not have a direct impact on competition but generate some type of result in other economic sectors, as well as in the economic development of countries (Bokestijn, 2021). We found the main impacts in sectors such as health, education, employment, education, employment and economic growth. In the health sector, according to (ITU, 2010), connectivity generates an increase in electronic health services, virtual and informative consultations for the knowledge of health status and disease prevention.

For the education component, according to (UNCTAD, 2011), an increase in mobile connectivity increases literacy and the development of new learning skills and allows more people to have access to learning. Likewise, in the case of employment, (Katz, 2009) indicates that the impact of technology increases people's connectivity and ability, lowers entry barriers in access to information and generates new sectors related to technology, which produces economic growth. According to (Röller & Waverman, 2002), the impact of the improvement of productivity in different sectors has an impact on the increase of productivity in a region in each period.

Similarly, when analyzing access charges, we find that in the case of Colombia and Chile they follow a downward-sloping trend over time, because they are values focused on recovering costs to the operator that supplies the infrastructure. This is shown in Figure 2.

Figure 2. Access Charges



Source: Author's formulation.

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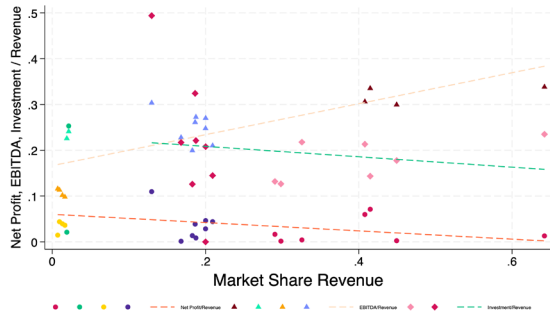
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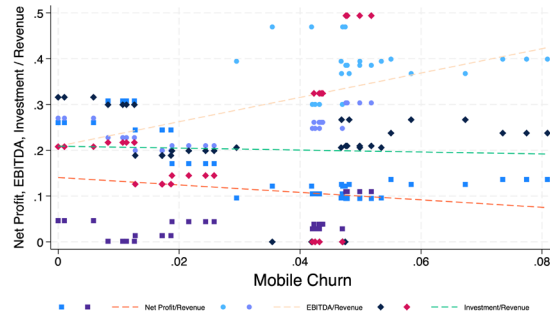
Appendix

A. Colombia

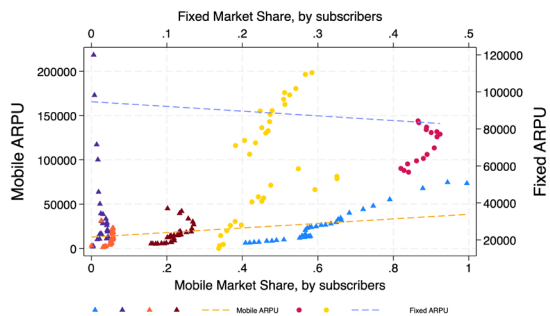
Figure 3. Colombia Correlations



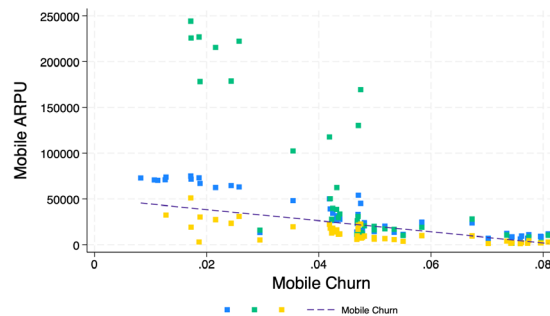
a. Relationship between market share and financial indicators



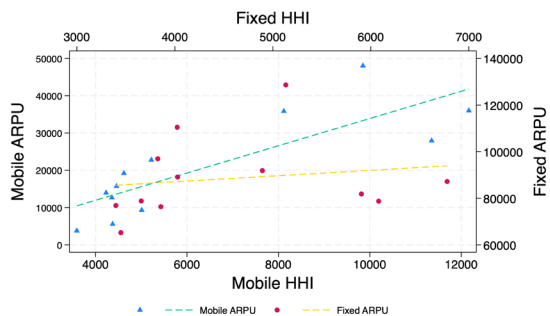
b. Relationship between mobile churn and financial indicators



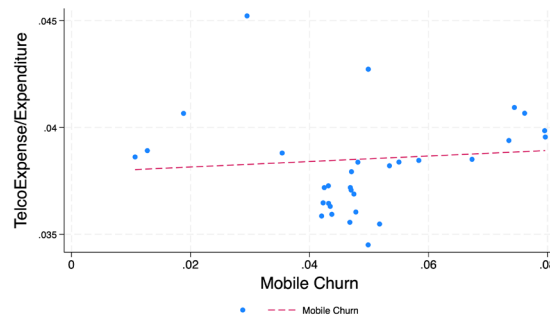
c. Relationship between market share and ARPU



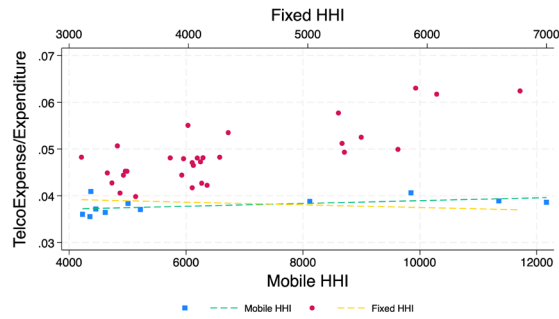
d. Relationship between mobile churn and mobile ARPU



e. Relationship between HHI and ARPU



f. Relationship between mobile churn and % of household expenses on telecommunication

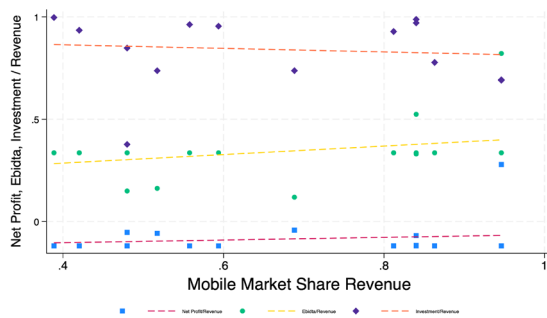


g. Relationship between HHI and % of household expenses on telecommunication

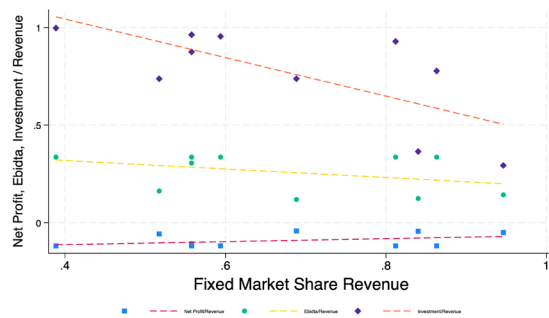
Source: Author's formulation.

B. Peru

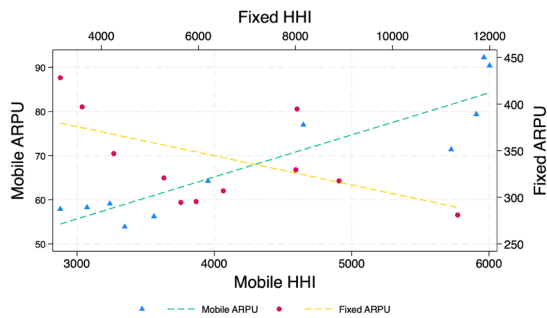
Figure 4. Peru Correlations



a. Relationship between mobile market share and financial indicators

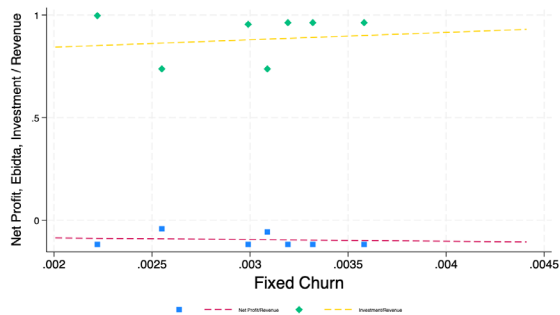


b. Relationship between fixed market share and financial indicators

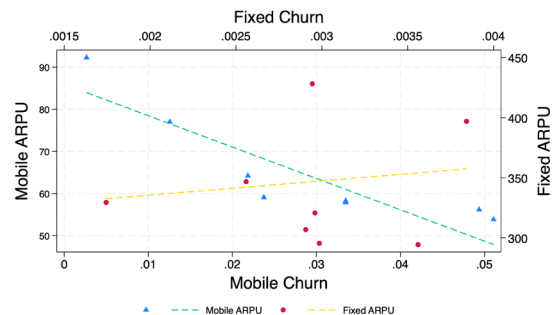


c. Relationship between HHI and ARPU

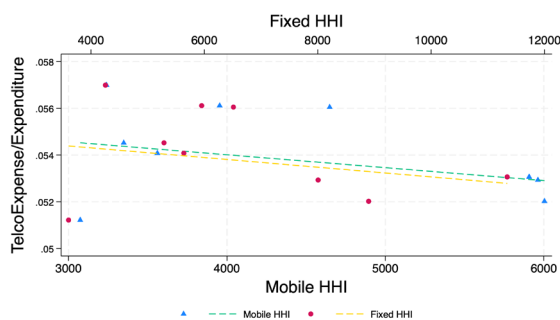
d. Relationship between mobile churn share and financial indicators



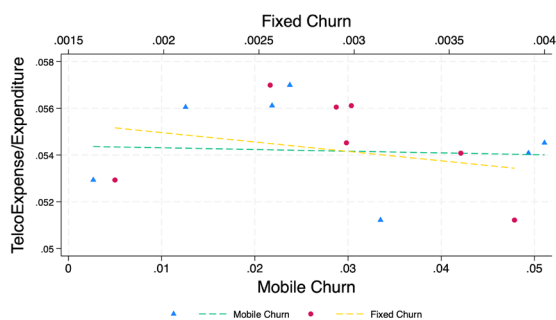
e. Relationship between fixed churn and financial indicators



f. Relationship between churn and ARPU



g. Relationship between HHI and % of household expenses on telecommunication

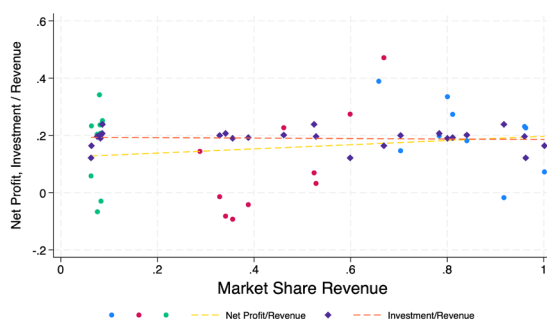


h. Relationship between churn and % of household expenses on telecommunication

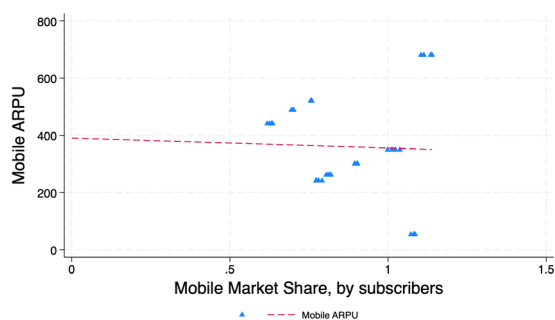
Source: Author's formulation.

C. Mexico

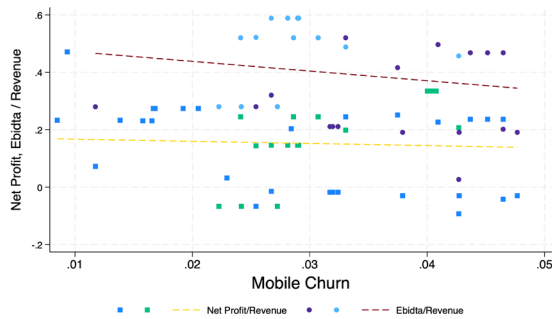
Figure 5. Mexico Correlations



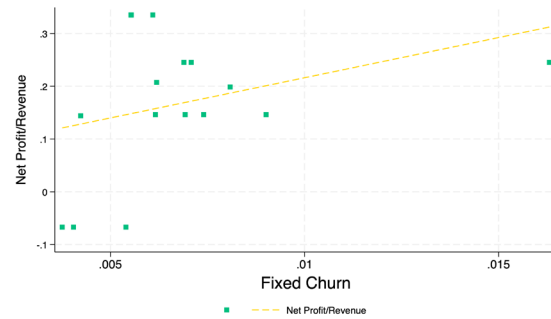
a. Relationship between market share and financial indicators



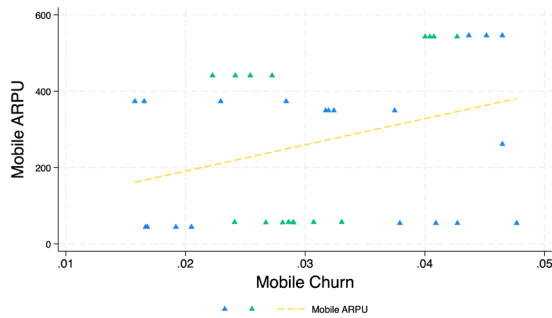
b. Relationship between mobile market share and mobile ARPU



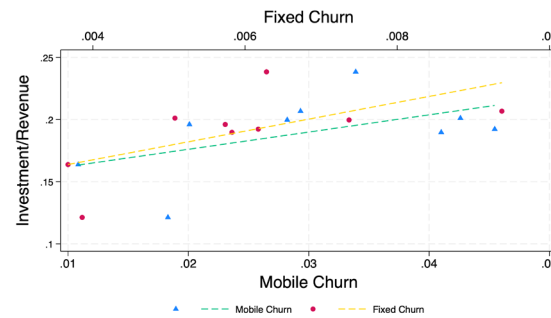
c. Relationship between mobile churn and financial indicators



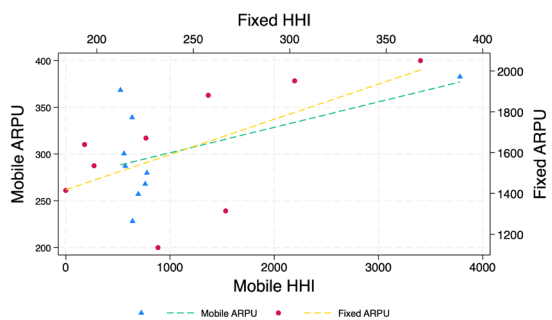
d. Relationship between fixed churn and net profit to revenue ratio



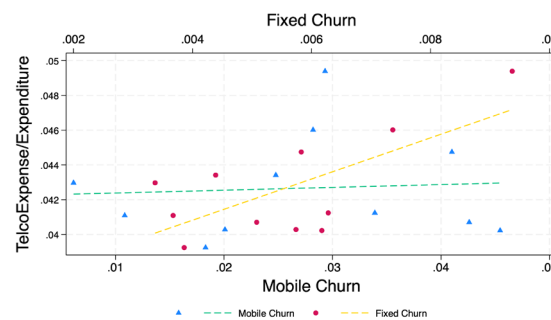
e. Relationship between mobile churn and mobile ARPU



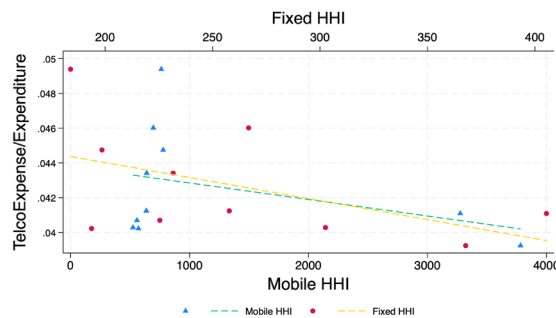
f. Relationship between churn and investment to revenue ratio



g. Relationship between HHI and % ARPU



h. Relationship between churn and % of household expenses on telecommunication

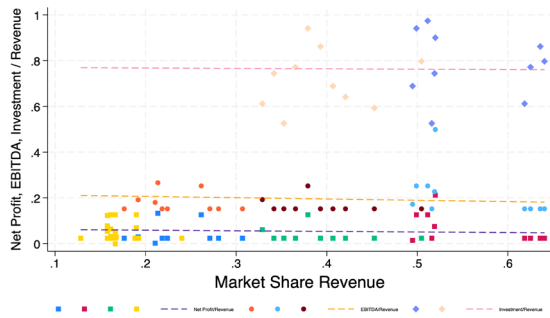


i. Relationship between HHI and % of household expenses on telecommunication

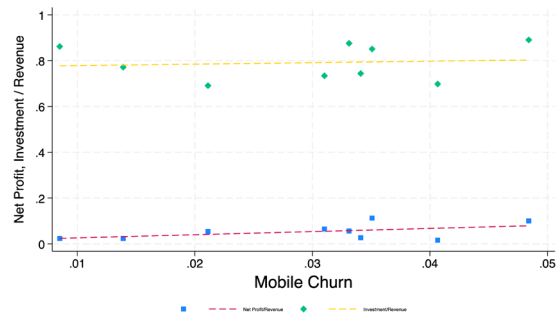
Source: Author's formulation.

D. Chile

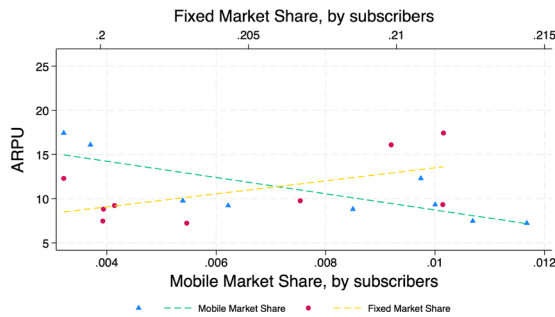
Figure 6. Chile Correlations



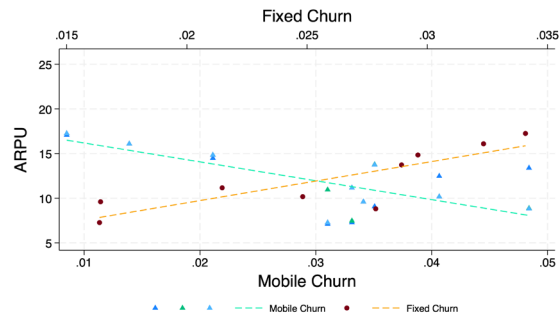
a. Relationship between market share and financial indicators



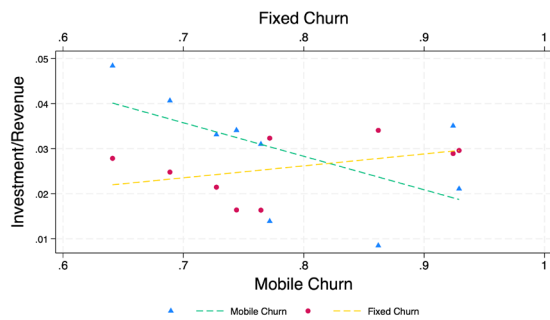
b. Relationship between mobile churn and financial indicators



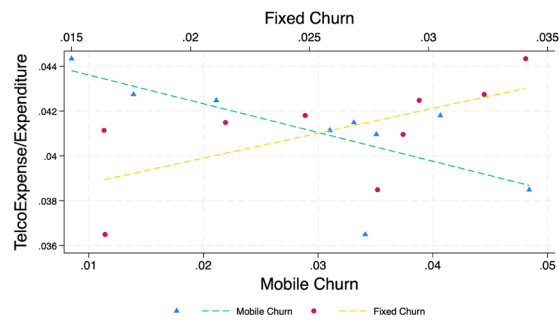
c. Relationship between market share and ARPU



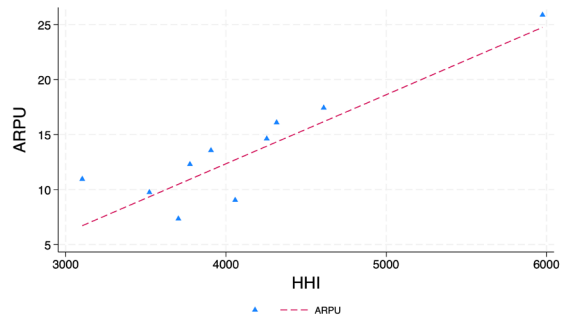
d. Relationship between churn and ARPU



e. Relationship between churn and investment to revenue ratio



f. Relationship between churn and % of household expenses on telecommunication



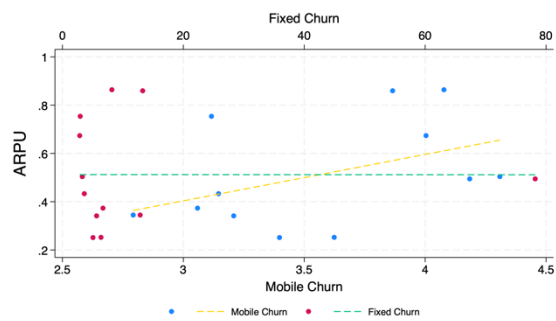
g. Relationship between HHI and ARPU

Source: Author's formulation.

E. Brazil

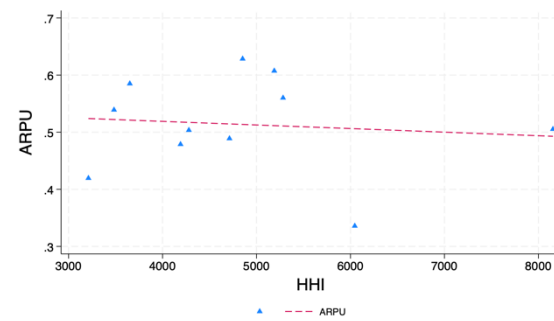
Figure 7. Brazil Correlations

a. Relationship between market share and financial indicators

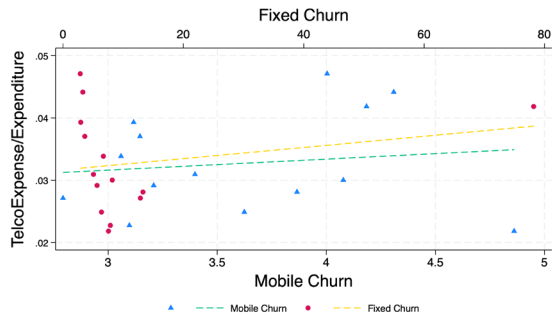


c. Relationship between churn and ARPU

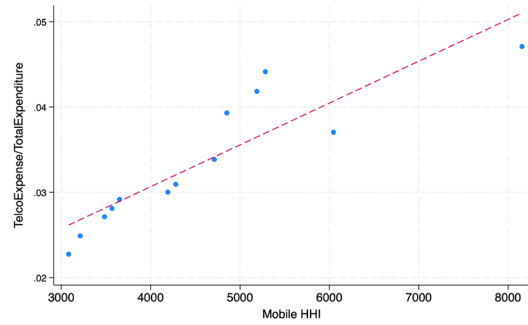
b. Relationship between mobile churn and financial indicators



d. Relationship between mobile HHI and ARPU



e. Relationship between churn and % of household expenses on telecommunication
Source: Author's formulation.



f. Relationship between HHI and % of household expenses on telecommunication