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ICT Innovation in Mexico:

Some Constraining Regulatory Aspects

The Competitive Intelligence Unit

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ABSTRACT

Latin America has a considerable gap regarding technology and science when compared to other members of the OECD and countries of Europe. Therefore, investing in innovation is more important than ever. However, Mexico and virtually every other Latin American country, spend less resources as a percentage of their GDP in Research and Development (R&D) each year.

There are many obstacles for innovation. This paper will focus on regulation and how it may affect innovation, directly or indirectly.

The first part of the paper addresses the situation of Latin America regarding science, technology, and innovation. In this section the WIPO Global Innovation Index is used to analyze Mexico's situation compared to similar countries in the region. Data was gathered to compare Internet and smartphones adoption, as well as analyzing the levels of digital skills and R&D, important aspects to promote innovation.

Afterwards, the paper describes the impact of regulation on innovation, based on theoretical and empirical evidence on how different types of regulation influence innovation.

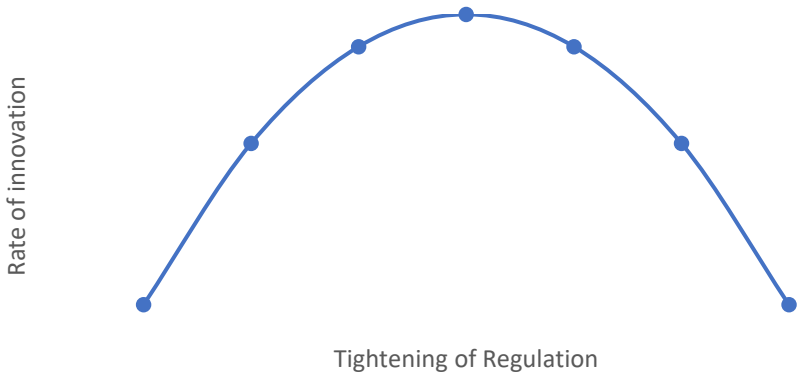
Finally, cases of technical regulation for the ICT sector in Mexico are analyzed to identify possible problems arising from these regulatory policies which may deter innovation and delay time to market new products.

By understanding why innovation is relevant for Mexico, how regulation impacts innovation and analyzing specific cases in the ICT and telecom sectors, the following conclusions are obtained:

- Even though regulation is desirable when facing market failure (monopolies, externalities, or other type of inefficiencies that affect competition), it could create other problems that affect, directly or indirectly, innovation and how consumers benefit from it.
- Every type of regulation the government implements (economic, social, administrative, or technical) has the potential to impact innovation negatively when execution instruments are poorly implemented, or it is too strict.
    - A poorly implemented competition policy can reduce revenues and disincentive innovation for leading-age agents.
    - Badly designed antitrust regulations may reduce incentives for entrant firms to innovate.
    - Regarding price regulation, price caps also reduce incentives to innovate.
    - Environmental and labor regulation may create compliance costs that can lead to the exit of certain companies such as SMEs from the market.

  - Technical regulation may become trade barriers that lower the efficiency of production, increase costs, and delay the time to market ICT products, ultimately affecting consumers.
- Even though regulation is normally recommended, a tight regulatory framework may cause other failures in the market. There seems to be an effect of regulation to innovation in the shape of an inverted U, where lenient regulations have a positive effect, but stricter regulations start to create the opposite effect.

Effect of regulation on innovation



Source: Elaborated by The CIU

- Mexican cases show how the development of technical regulations to meet certain requirements to protect consumers from health, environmental or market problems, can cause incentives to slow down or stop innovation processes.
- Delayed or incomplete regulation can create barriers to the creation of new technologies by imposing compliance costs, which affects markets and consumers in the long term.

Furthermore, the following recommendations are suggested:

- Regulators and federal authorities should establish continuous public-private collaboration working groups where government and industry concerns can be discussed.
- Modifications to the Federal Telecommunications Law need to be considered where new innovative regulatory schemes such as sandboxes are considered.
- Existing Mutual Recognition Agreements for ICT devices between de Government of Mexico and Governments of U.S. and Canada, established in the USMCA, must be implemented.
- Communication and coordination between regulators and federal ministries need to be strengthened (e.g., IFT and Ministry of Economy).

- Continuous mandatory training on WTO Technical Barriers to Trade Agreement for regulatory and federal authorities should be implemented.
- Best international regulatory practices and collaborative schemes should be considered, taking into account Mexico's market conditions.
- Regulation regarding Conformity Assessment Procedures and approval must be carefully developed and executed. Complex or unnecessary requirements increase costs to manufacturers and importers which can be transferred to ICT products' prices to the detriment of consumers.
- Regulatory agencies and federal authorities should encourage and facilitate the setting up of new testing labs and certification bodies to open competition.
- The scarcity of testing labs may delay the introduction of new ICT products and technologies. Waiting times to test and certify new products may take longer, affecting the time to market innovative products in detriment of consumers.
- Regulatory agencies must ensure that low quality goods do not reach the hands of customers. However, excessively burdensome regulation for that purpose may punish manufacturers and inhibit formal importers, resulting in an inefficient solution to the problem.
- Environmental and health regulation regarding ICT devices needs to be carefully drafted and follow a proper public consultation where industry concerns should be listened.

1) INNOVATION: A GENERAL VISION

Innovation is the design and implementation of significant changes in products, services, processes, or organization of economic agents with the purpose of improving results or quality in a more efficient basis.[1] When applied in the market this innovation allows not only production efficiencies but provide specific benefits to consumers.

It also promotes greater efficiency in the market, improving processes that can result in a decrease in prices or an increase in quality, thus creating greater surpluses for both consumers and producers, which increases the social benefit.[2]

"The relevance of science, innovation, and new technologies for the development of the economy and society is undeniable: they have become fundamental tools for the transformation of productive structures, the rational exploitation of natural resources and health care, and for food, education and other social needs."[3] (CEPAL, 2021)

Governments have incentives to intervene in the innovation processes to accelerate it, or to correct market failures.[4] However, this regulation can be counterproductive if not designed/implemented properly and have relevant negative impacts on research and development activities, affecting innovation in the long run.

Innovation is related to the use of technology and the development of digital capabilities to transform economy and society, while technologies need innovation to be easier and safer to be enjoyed by users.

This section compares the state of innovation in Mexico to other regional economies and analyzes the current state of access to Information and Communications Technologies (ICT) in Latin America, particularly, Internet penetration, smartphone adoption, digital skills, and research and development.

[1] OCDE. (2006). "Manual de Oslo: Guía para la recogida e interpretación de datos sobre la innovación". Available at: https://bit.ly/3afslRd

[2] Ídem.

[3] Comisión Económica para América Latina y el Caribe (CEPAL). (2021). "Innovación para el desarrollo: la clave para una recuperación transformadora en América Latina y el Caribe" (LC/CCITIC.3/3), Santiago.

[4] Ídem.

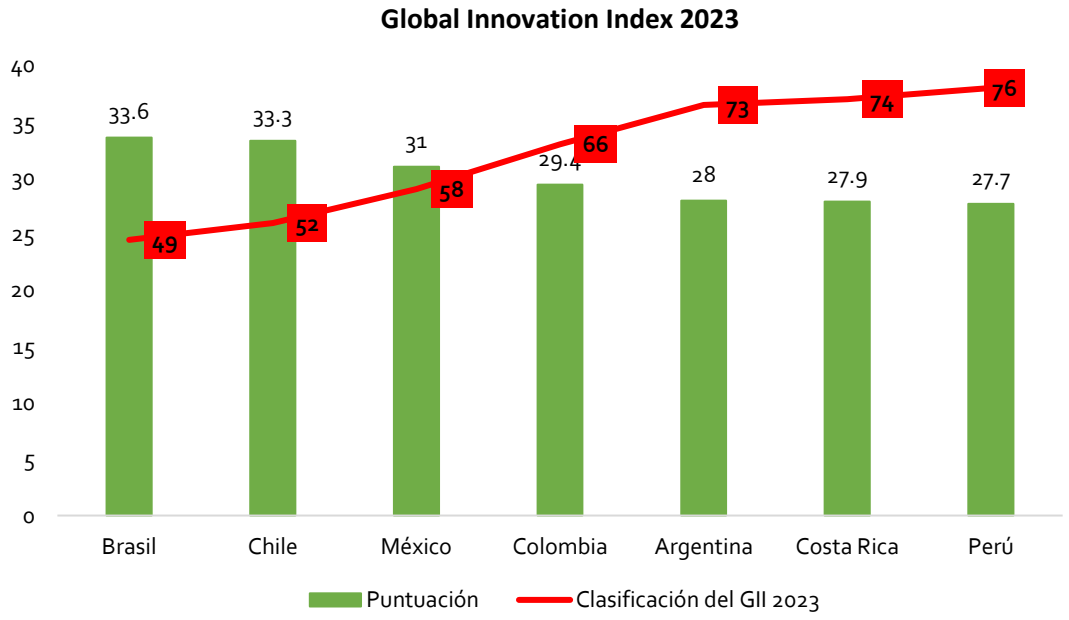
A) STATE OF THE INNOVATION

The Global Innovation Index (GII) developed by the World Intellectual Property Organization (WIPO) captures the innovation ecosystem performance of 132 economies and tracks the most recent global innovation trends.

The GII studies seven metrics to provide a rank: institutions, human capital and research, infrastructure, market sophistication, business sophistication, knowledge and technology outputs, and creative outputs. Each category is quantified and then ranked among countries.

The graphic below shows the GII 2021 for the Latin American countries analyzed in this section.

In Latin America, the top three innovation economies by region were Chile (53), Mexico (55) and Costa Rica (56).[5] They are still far from the most innovating countries Switzerland, Sweden, and United States with a score of 65.5, 63.1 and 61.3, respectively.



Source: The CIU with information from WIPO

[5] WIPO. (2021). "Global Innovation Index 2021: Tracking Innovation through the COVID-19 Crisis. Geneva: World Intellectual Property Organization.

Data shows that no Latin American country is ranked in the top 50 and Mexico has been the only economy which has improved its ranking position consistently over the past 10 years.[6]

Regarding metrics integrating the GII, Mexico's most visible deficiencies are institutions and infrastructure. On the other hand, Brazil's R&D expenditure is equivalent to some well-developed European countries.

Regarding institutional aspects, Mexico performs 94 (like Oman, Moldova, Russia, Tunisia, and others). In this regard, Mexico shows an important lag on regulation quality (ranks 65, which is below its GII general rank).

Accordingly, more work must be done to enhance innovation for Mexicans to access its advantages. Mexico requires improvements on regulation quality by empowering the "ability of the government to formulate and implement sound policies and regulations that permit and promote private-sector development".[7]

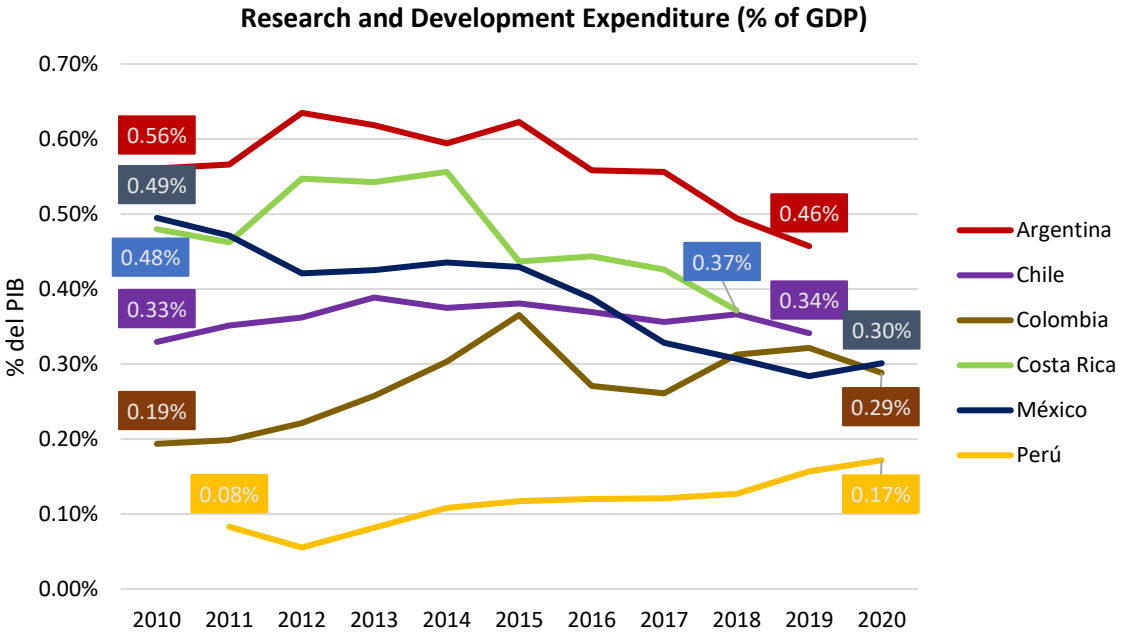
B) Research and Development

Research and development (R&D) are key to innovation because it is the process of generating new knowledge and ideas. The relative expenditure in R&D in Latin America is very low compared to the OECD countries average. In 2020, it was 0.63% of their Gross Domestic Product (GDP), Brazil is the country in the region that spends the most on R&D relative to their GDP, reaching 1.17%.[8]

[6] *Ibid. p.183*

[7] *Ibid*. p. 29

[8] UNESCO, Institute for Statistics. (2022). "Research and development expenditure". Available at: http://uis.unesco.org/



Source: The CIU with information from World Bank and UNESCO

The graphic above shows the R&D expenditure as a percentage of GDP in the Latin American countries analyzed in this section. Brazil is excluded because its percentages are much higher than those of other countries. The case of Brazil not necessarily should be used as reference given that manufacturers are mandated to produce and invest in R&D in the country in order to commercialize their products. However, these products cannot be exported resulting in very high prices of ICT products for Brazilians.

It is remarkable how most of the countries, except for Colombia and Peru, are spending less percentage of their GDP in R&D. In the case of Mexico, this percentage has decreased from roughly 0.50% to 0.28% in the last ten years. This is a matter of concern because there have been many regulations in the technology and energy sectors in the last decades, which means they are not working as intended.

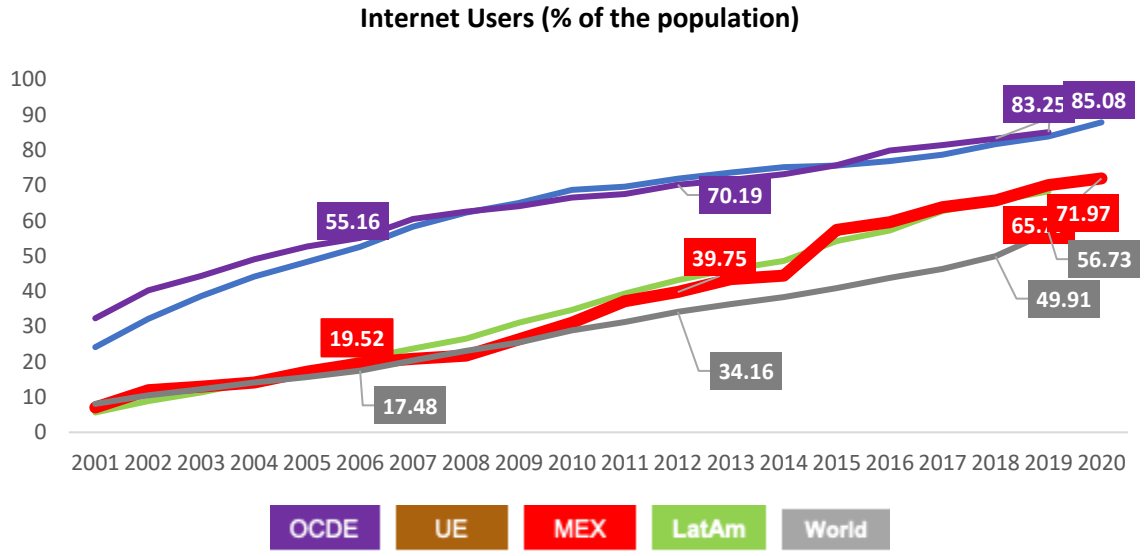
The use of technology is relevant for innovation processes as well as to improve productivity. The following two sections provide an ICT penetration overview to understand how Latin American economies are prepared to create and benefit from innovation.

C) Internet and Devices

Measuring Internet access is fundamental because it is the basis for developing innovation and technology. Connectivity makes possible to produce and provide goods and services

in a more efficient basis, ICTs are a mechanism to boost productivity by accelerating technologies and production processes.

The figure below shows the percentage of users from 2001 to 2020. Logically the worldwide trend has gone upward, and Latin America is no exception. Although the situation has improved, there is still a gap when the region is compared to developed countries.



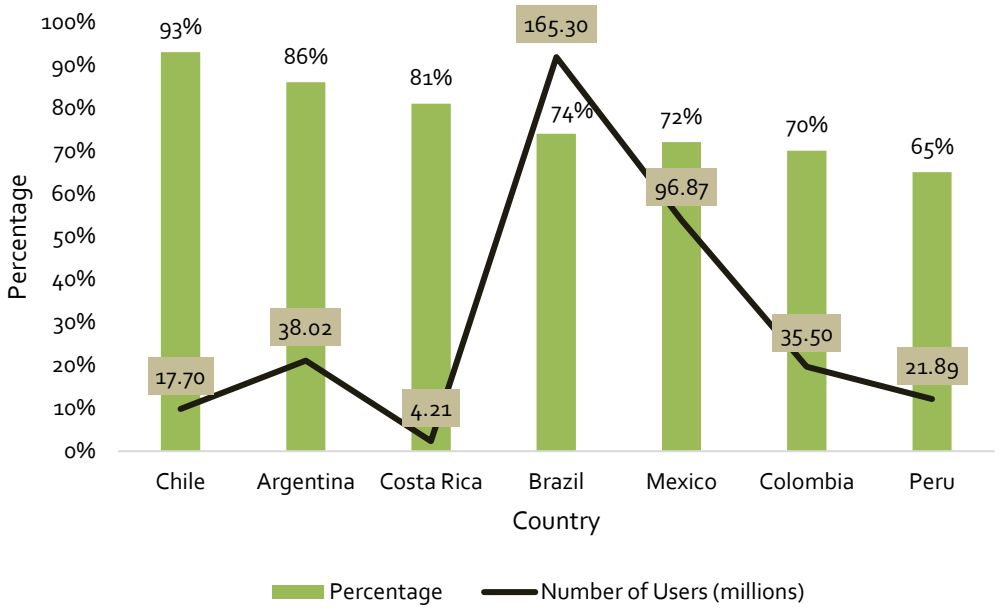
Source: The CIU with information from World Bank

When analyzing a sample of Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Mexico, and Peru) Internet access surpasses 50% penetration.

The percentage of the population with Internet access goes from 65% and 93% depending on the country.[9] In other words, there is not universal access in any economy, and there is a great difference among them. The average of the countries analyzed is 77% access. Excluding Chile, this measure drops down to 75%.

[9] ITU DataHub. (2022). "Individuals using the Internet, by region". Available at: https://bit.ly/3zGh2de

Internet Users & Number of Internet Users, by Country in Latin America, 2022 (%)



Source: The CIU with data from ITU

The figure also shows the number of Internet users in the analyzed countries. Brazil is the Latin American country with the highest number of Internet users. According to data from January 2022, a total of 165 million Brazilians use this network. This figure is 96 million for Mexico. These two countries correspond to the countries with the largest number of inhabitants (210.56 million and 130 million).[10]

Smartphones usage is also an important metric to measure innovation since they tend to be the main Internet access device for Latin American people. Portability, processing capacity, memory, among other characteristics, make these devices a fundamental element for connectivity and the appropriation of its benefits.

Smartphones adoption has increased over time; 2020 showed atypical data because of the impact of the pandemic on the economy, but once the health crises concluded, the adoption returned to rising adoption patterns.[11]

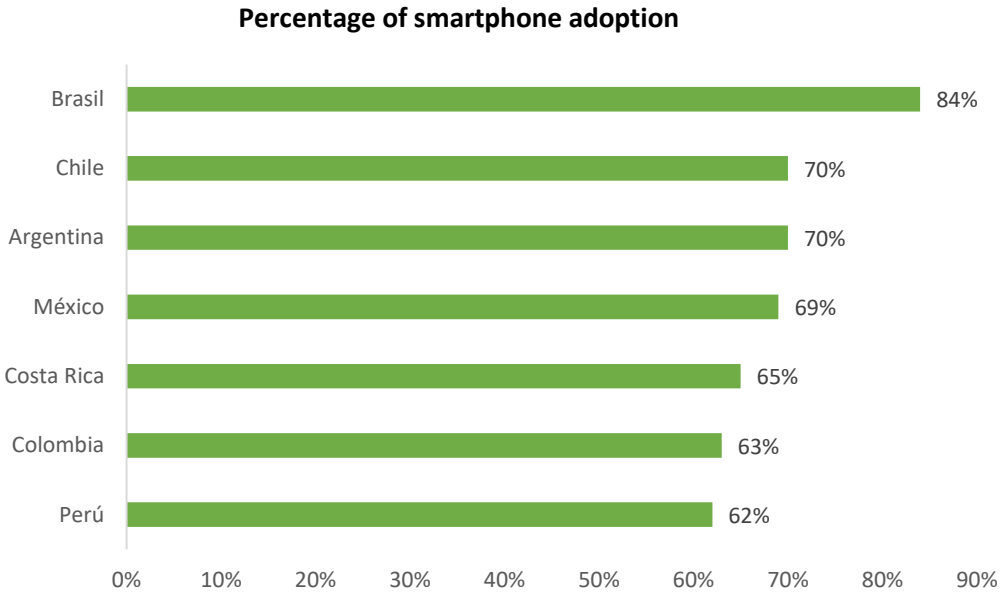
The figure below shows the adoption of smartphones in Peru, Colombia, Costa Rica, Mexico, Argentina, Chile, and Brazil in the most recent year available. All countries except Brazil have a smartphone adoption rate between 60% and 70% of the population.[12]

[10] ITU DataHub. (2022). "Total population, by region". Available at: https://bit.ly/3JKkKHs

[11] Gartner. (2021). "Global smartphone sales to end users from 2018 to 2021, by region (in million units)." Obtained with Statista Portal.

[12] GSMA. (2021). "La Economía Móvil en América Latina 2021". Available at: https://bit.ly/3zxWkNU

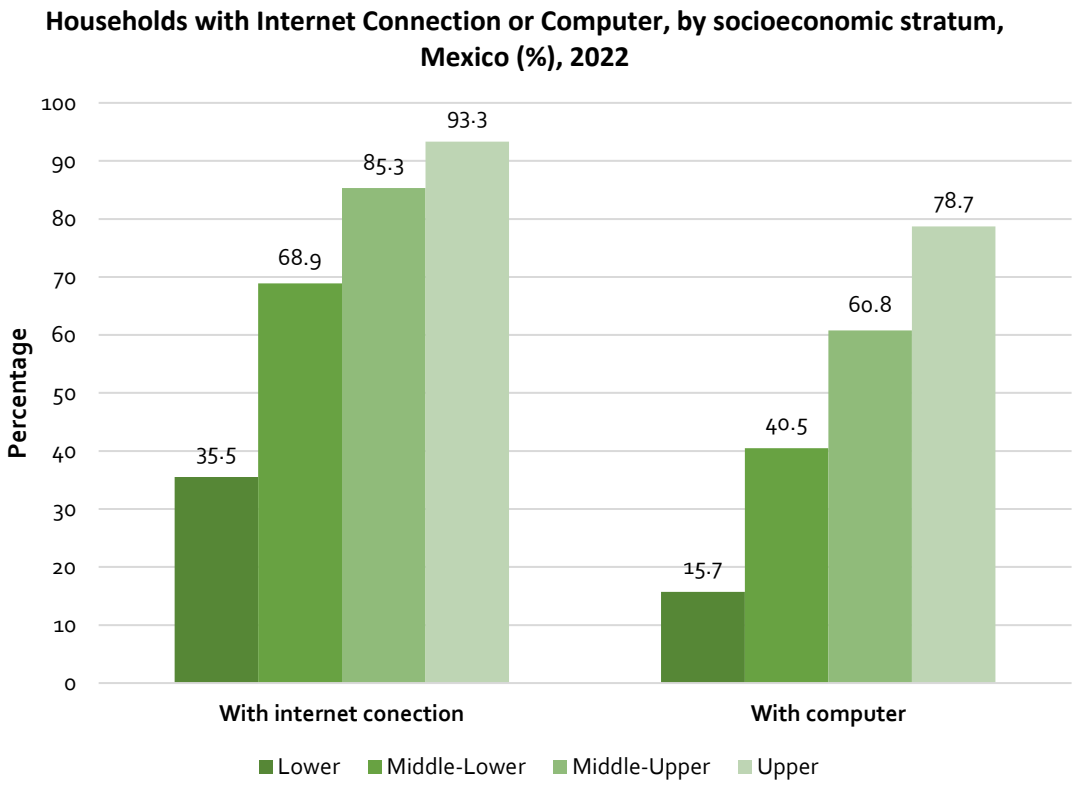
Households' income is a major obstacle for ICT access and therefore a barrier to innovation in Latin America.



Source: The CIU with ENDUTIH and GSMA data

As stated before, the economic condition of households impacts IT access. For example, in Mexico, the percentage of households with computers varies considerably by socioeconomic stratum. While 79.7% of households in the highest socioeconomic level are equipped with computers, this indicator drops to 16.4% in the lowest level. The same is true for Internet access: in the highest level, the percentage of households with Internet is 92.1%, while in the lowest level drops to 34%.[13]

[13] The Social Intelligence Unit. (2022). "Acceso a Internet y Computadoras entre las Entidades Federativas". Available at: https://bit.ly/3b8N3Td

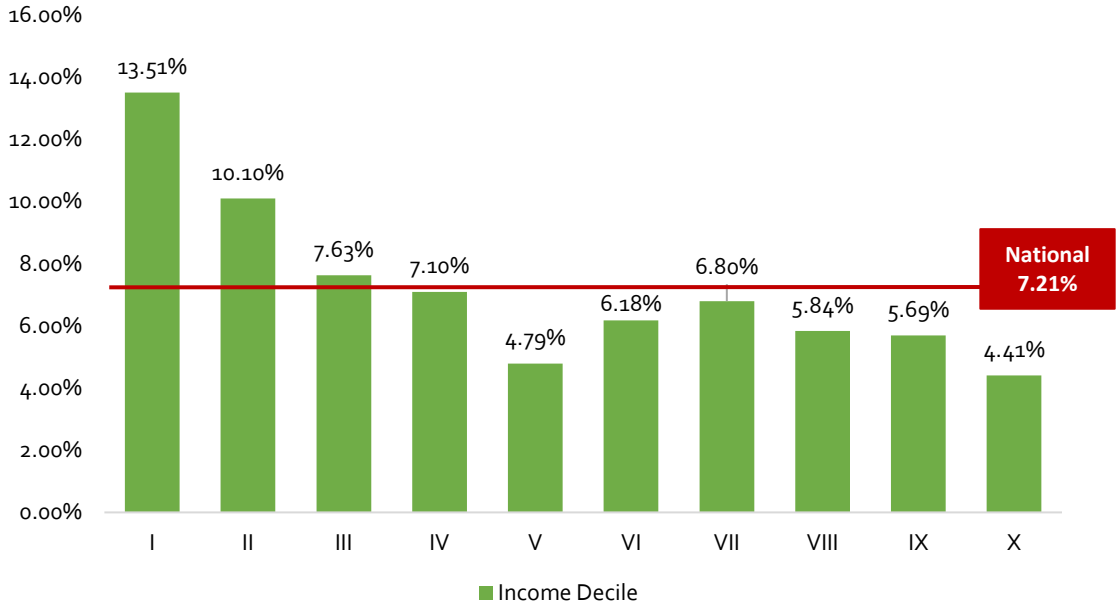


Source: The CIU with information from INEGI (ENDUTIH 2022)

On the other hand, as the graphic below shows, at national level households spend, on average, the equivalent of 7.2% of their income on the mobile. However, the first three deciles do so in a proportion above the national average.[14]

[14] The Social Intelligence Unit. (2022). "Brecha de gasto de los hogares en smartphone". Available at: https://bit.ly/3b8N3Td

Household spending on mobile phones (% of income per decile), in Mexico



Source: The CIU

The spending share on smartphones in household income is a crucial element explaining the adoption gap between the poorest and the richest in Mexico and Latin America.

D) Digital Skills

Digital skills are the set of knowledge related to the use of communication tools, access, and production of information of ICT.[15] In this paper, digital skills refer to the ability of users to effectively use and understand Information Technologies.

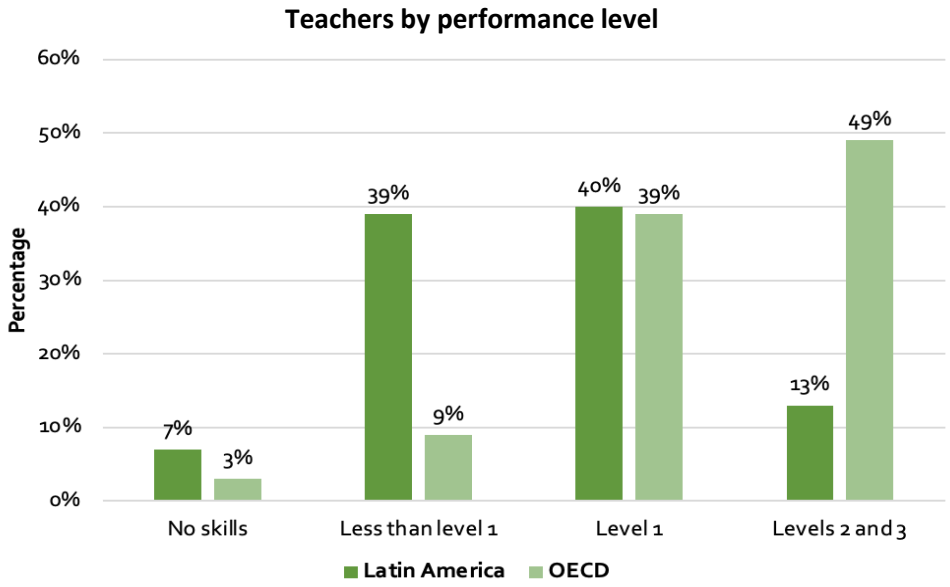
By measuring how Latin American countries are performing in digital skills, this paper refers to the study conducted by the Development Bank of Latin America (CAF), which observes the results that teachers in some Latin American countries - Chile, Ecuador, Mexico, and Peru - obtained from the PIAAC test.[16] Specifically, PIAAC assesses the ability to solve problems in a digital environment. The CAF study is useful because categorizes digital skills in levels 1, 2 and 3. People below level 1 can only perform a task that does not require any reasoning or transformation of information, while people in level 1 can only use familiar applications, such as email or a web browser, to perform actions that require few

[15] Universidad Nacional Autónoma de México. (2022). "Matriz de Habilidades Digitales". Available at: https://bit.ly/3zanBVo

[16] An international OECD survey that measures the digital and math and reading comprehension skills of the adult population in 39 participating countries.

steps and simple reasoning. People at these levels would not be able to fill out a form in a web browser that they have not seen before. In contrast, practically half of the teachers in the group of OECD countries analyzed are at performance levels 2 and 3.[17]

The figure below shows that most teachers in Latin American countries analyzed perform in level one or lower, while in the case of the average OECD country, most of them are level one, two, or three. 7% of the Latin American teachers in the sample could not complete the tasks on computer, 39% were at a level lower than one, 40% obtained level one and only 13% obtained level two or three.[18]



Source: The CIU with data from CAF

These results suggest that there is a deficiency in digital skills in Latin America, which is reflected in the gap between teachers in the region and those in OECD member countries. This deficiency in the region implies a systematic problem in the process of teaching digital skills.

Latin American countries seem to share similar problems regarding the appropriation and creation of innovation: lack of R&D investment, and low ICT access due to socioeconomic aspects. One of the most interesting Mexico's singularities is the lack of well-implemented regulation which can deter innovation from the private-sector perspective. Before analyzing some specific cases, this paper will provide an overview about the discussion of regulation and how is correlated with innovation.

[17] Development Bank of Latin America. (2020). "¿Qué habilidades digitales tienen los docentes de América Latina?". Available at: https://bit.ly/30uc4LI

[18] *Ídem*.

2) Digital Economy Regulation

Regulation refers to all those rules or laws that are issued by an agency (usually governmental) to protect social, economic, political, or technical aspects that are in the public interest.[19] The objective of this procedure is to maintain order, through rules, to have a better control and guarantee economic competitiveness and other rights that members of a community may have.

According to the Ministry of Economy (SE by its acronym in Spanish) of Mexico, there are three types of regulation: economic regulation, social regulation, and administrative regulation.[20] However, for the purpose of this paper, a fourth and a fifth type of regulation are also introduced: technical regulation and patents.

Technical regulations are those designed to establish technical characteristics that processes, products, or services must meet when they may constitute a risk for the safety of people[21] or when it is necessary common production or manufacturing characteristics (product standardization).[22]

In Mexico, examples of technical regulations are Mexican Official Standards (NOM by its acronym ins Spanish), or the technical dispositions issued by the Federal Institute of Telecommunications (IFT by its acronym in Spanish).

Types of Regulation

Economic Regulation	Social Regulation	Administrative Regulation	Technical Regulation	Patents
It refers to the provisions regulating market; these are specifications that companies must comply with to ensure competitiveness.	This regulation seeks to protect people's health and environment, guarantee safety, and to establish guidelines for labor practices.	This oversees organizing the operation of public administration to provide services and goods.	This regulation establishes the characteristics that processes, products, or services must meet.	Exclusive right granted for an invention, which is a product or a process that provides, in general, a new way of doing something, or offers a new technical solution to a problem.

Source: The CIU with information of WIPO, Ministry of Economy and Ministry of Health

For the purposes of this paper, we will focus on economic and technical regulation (also addressed in the examples of the following section) since they directly affect innovation processes in the private sector.

[19] COFEMER. (2010). "¿Qué es la regulación?" Available at: https://bit.ly/3P6IIoI

[20] Secretaría de Economía. (2018) "¿Sabes qué es la regulación?". Available at: https://bit.ly/3MEk1HL

[21] Secretaría de Salud. (2015). "Normas Oficiales Mexicanas" Available at: https://bit.ly/3P9dKVK

[22] SE (2018), "What is normalization or standardization?". Available at: https://bit.ly/3Qk4r6I

Regarding economic regulation, the reasons why the market requires lie behind the presence of imperfections such as natural or artificial monopolies, barriers to entry, information problems or simply lack of competition.

In order to correct these failures, it is necessary to implement instruments such as price, quantity, or quality regulation, control the access or exit of agents in the market, sanction those who do not seek competition, give recommendations, or authorize mergers among other instruments.

From the economic perspective, regulation is justified in the presence of failures within a system in which a regulatory agency must intervene to correct them. Thus, for example, if a market is not efficient or competitive due to a failure mentioned before, regulatory agency intervention is desirable if this will bring the market to a higher level of efficiency.

Other market failures include externalities, which are addressed by Mexican NOMs. In these cases, the market is efficient and competitive, but its existence, the production and sale of goods, can generate problems in other sectors outside the market, such as health problems or environmental pollution, making it necessary to intervene. Hence, it is desirable for the government to publish standards to establish limits to evade or prevent these types of issues.

However, not all regulation is desirable. In many cases, regulators may intervene in markets negatively affecting their efficiency, even worsening the result. A regulation may create other negative externalities, and, although it corrects an existing problem, it may generate new ones that may even worsen more than the benefits of the regulation.[23]

These situations are very common in the digital economy, since this market, due to its nature and its rapid technological evolution, may contain many problems within, such as the existence of natural monopolies or externalities. However, by regulating markets, even worse externalities can be created, such as a decrease in quality or quantity of products, and services, as well as disincentivizing innovation and therefore R&D investment.

As mentioned before, regulation aims at achieving market efficiency, which can be static or dynamic. Static efficiency refers to minimizing production costs, while dynamic efficiency involves the demand for creation and innovation.[24] Static efficiency is short-term, while dynamic efficiency involves long-term welfare improvement. Both efficiencies

[23] Parker, D. (2002). "Economic Regulation: a review of issues". Available at: https://bit.ly/3QAhil3

[24] Burreau, Marc (2001). "Regulation and innovation in the telecommunications industry". Available at: https://bit.ly/3xtNb6H

are important for achieving efficiency in the market. However, the regulator can worsen efficiency in the long run by improving it in the short run.

It is important to mention that regulation implies a cost, so the benefit should be greater. If the cost of regulating is greater than the benefit of doing so, then it is better not to intervene in the market. Often, these long-term costs are hard to estimate so regulation may negatively impact innovation in many cases.

When dealing with price, quantity, or quality regulation, these instruments are regularly employed to correct non-competitive markets to ensure adequate competition. In the case of the digital economy, the low number of producers in the digital economy is related to market structural reasons such as economies of scale (the greater the quantity produced, the lower the average cost), economies of scope (the average cost is reduced with the production of two or more different goods), network economies (the product is more valuable depending on the number of compatible products on the market) and sunk costs, which make it more complicated for a company to enter when there are already companies that can provide such goods and services at a lower cost.

Price, quantity, or quality regulation can increase consumer surplus (monetary benefit that consumers obtain by acquiring a good or service at a lower price than they would initially be willing to pay) and prevent producers with market power from appropriating it (by raising prices or lowering quality). However, in the presence of natural monopoly (monopolistic firm can supply the market at a lower cost and with higher quality than the competition scenario) it is difficult for other agents to enter the market, and if the producer's profit is greatly affected, this may cause the producer to stop investing in products that do not generate profits, affecting the creation of new goods and services in the future.

In turn, controlling the access or exit of agents in the market to counteract the existence of entry barriers can have the same result. On the one hand, if the entry of agents who are not efficient enough is promoted, it can affect those who are, causing those who are not efficient to lack the tools to innovate and provide quality products, but due to poor regulation they remain in the market, while those who are efficient do not have the profits to be efficient, discouraging innovation.

Therefore, regulation is desirable if it is necessary and well planned and market structure is previously studied. In many cases, regulation of a market can led to lower market efficiency: although it corrects existing failures, it can create new and even worse negative externalities, and in the long run it can affect innovation, which is very important in a sector such as the digital economy. In the following section we will look at some specific examples of the impacts that regulation can have on innovation.

A) IMPACTS OF ECONOMIC REGULATION

There are three ways of looking at regulation when talking about innovation: i) regulation dedicated to promoting innovation; ii) regulation for creating pressure for innovation, and iii) regulation that can create a burden on innovation or even impede it.[25]

This section focuses on analyzing the different impacts that regulation can have on innovation, which can promote or discourage it depending on, among others, the type of market, size, and time.

The objective of competition policies is to encourage competition to make markets more efficient. More competition implies lower prices, higher quality and more variety of goods and services, which would increase consumers' utility. However, an "excess of competition" could imply that imitation activities become more popular for firms than innovation activities, since the surplus revenue from innovating is reduced.

According to Aghion et al. (2005), the positive impact that competition generates on innovation may change to a negative relationship if competition is too intense, generating an inverted U relationship between competition and innovation[26]. Bassanini and Ernst (2002) found a negative correlation between the intensity of regulation in the market and the intensity of R&D spending in OECD countries.[27]

However, there are also studies that demonstrate positive impacts. A study by Koch et al. (2004) suggests that antitrust laws, intellectual property rights (IPR) regulations, labor market regulations, administrative regulations, and inward investment regulations have a positive effect on research and development intensity in G7 countries. They also found that IPR policies and antitrust policies are substitutes for inducing innovation, as strengthening one of these policies reduces the impact the other one has on innovation.[28]

This reinforces the model presented by Aghion in a regulatory context, where intensifying regulation too much can decrease innovation intensity. Thus, a regulatory policy can have a positive impact on innovation, but its abuse or poor implementation can discourage innovation.

On the other hand, the effects of price regulation depend on its implementation. If price regulation causes firms to ensure a minimum income or reduce their risk, the incentives to innovate increase. However, if this regulation limits firms' income, they have

[25] Blind, Knut. (2012). "The Impact of Regulation on Innovation". Available at: https://bit.ly/3aUYiOH

[26] Aghion, Philippe. (2015). "Competition and Innovation: An Inverted-U Relationship". Available at: https://bit.ly/3Qc5sy1

[27] Bassanini and Ernst. (2002). "Labour Market Institutions, Product Market Regulation, and Innovation". Available at: https://bit.ly/3xdBEIM

[28] Koch et al. (2004). "The impact of regulatory policies on innovation: Evidence from G-7 countries". Available at: https://bit.ly/3xoCrXi

less incentive to innovate, since having a technological advantage would not imply a higher profit if the price were limited, while the cost of such innovation is maintained.

Figure 12. Effects of the Economic Regulation

Type of regulation	Negative effect	Positive effect
Competition enhancing	Reduces rent for innovators. Impedes cooperation in research and development.	Ensures incentives to invest in innovation.
Antitrust regulation	The dominant company has less incentive to invest in innovation.	Allows other companies to enter the market and put pressure on dominant companies through competition.
Mergers and acquisitions	Limits acquisition pressure and thus incentives to innovate.	Enables efficient acquisition of innovative companies.
Market entry regulation	Prohibits the entry of potential innovative companies.	Reduces competition for incumbents
Price regulation	Price caps reduce incentives to innovate.	Minimum prices ensure rent and reduce investment risks.
Regulation of natural monopolies	High price pressure and low rents do not allow investments in research and development.	Incentives to seek more efficient productivity.

Source: The impact of regulation from Knut Blind

It is worth mentioning that, depending on the type of regulation, the results in terms of impacts on innovation may vary. Thus, a price cap regulation (that sets a limit on the prices that providers can charge) may generate greater incentives to innovate than a rate-of-return regulation (which consists of setting prices that guarantee the firm sufficient revenues to cover observed operating costs and depreciation and obtain a return on the invested asset).

The work of Chunrong Ai (2002) examined the impact of state incentive regulation on network modernization, aggregate investment, revenues, costs, profits, and local service tariffs in the U.S. telecommunications sector between 1986 and 1999. They found evidence that network modernization is greater with price cap regulation, profit sharing regulation, and rate moratoria than with rate-of-return regulation.[29]

Price regulation and market entry are examples of types of regulation that are most likely to affect innovation in the digital market. On the one hand, price regulation alters returns in the industry, which in turn alters incentives to innovate. On the other hand, both

[29] Ai, Chunrong. (2002). "The Impact of State Incentive Regulation on the U.S. Telecommunications Industry". Available at: https://bit.ly/3aRCbZo

regulations can modify market entry, which changes the incentives to innovate with respect to the entry of new firms.

Similarly, the effect may vary not only from the type of regulation, but also from the timing of the regulation.

Marc Bourreau and Pinar Dogan explain the existence of two ways of regulating and show the difference between ex ante asymmetric regulation and ex post competition policy. The former refers to a specific regulation for the economic agent with market power, without considering its competitors, to prevent this agent from abusing its dominant position. In contrast, competition policies seek to control the market after seeing how it develops, where the regulatory agency already has information about the companies and the market.[30]

Based on the previous assessment, it must be expected that ex-ante regulation may reveal greater barriers to innovation. On one hand, price regulation of a dominant firm may cause it to lose incentives to innovate because its revenues are controlled, while regulation of market entry also affects innovation, which can be a preventive mechanism to avoid the entry of other competitors and maintain its market power.

Ex-ante regulation may decrease the rate of innovation of the dominant firm. However, it may increase the incentives to innovate of the other firms in the market. Lyon and Huang (1995) found that asymmetric regulation can discourage imitation, making innovation by entrants or small firms profitable, thus accelerating innovation.[31]

Although, on the other hand, strong regulation can enable entry of firms that are not efficient but have a competitive advantage by being unregulated, it affects innovation in the long run by introducing inefficient technologies sufficient to stay in the market, discouraging research and development.

In contrast, under ex post competition policies, the preponderant companies have more control over their decisions, which increases the incentives to invest in research and development. Those who engage in anticompetitive practices such as price predation or collusion can be punished and deterred. However, penalizing dominance that is the result of innovation and technological improvements can be inefficient, even more inefficient than leaving the company with market power, especially in the long run, since innovation is punished.

[30] Burreau, Marc. (2001). "Regulation and innovation in the telecommunications industry". Available at: https://bit.ly/3xtNb6H

[31] Lyon, Thomas. (1995). "Asymmetric Regulation and Incentives for Innovation". Available at: https://bit.ly/3zANsaD

Thus, all types of regulation may have both negative and positive effects on innovation. It is important to distinguish each case to understand what the best regulation is (if one is required) and to understand that excessive regulation can have worse results in the long run, since choosing static over dynamic efficiency implies stopping innovation and its incentives.

B) Impacts of Other Types of Regulation

As stated above, in addition to economic regulation, there is also social and administrative regulation. The former ensures labor rights, access to rights such as health and safety, as well as environmental protection. The second aims to regulate the functioning of public administration.

Similar to economic regulation, the results of these types of regulation can be ambivalent, depending on how stringent the regulation is and how it is implemented.

For example, environmental regulation aims to improve the quality of the environment, either by punishing companies that pollute or by rewarding those that do not. In the first instance, the impact on innovation would be expected to be positive, as it would create incentives to pursue new, less polluting technologies. However, excessive regulation can have the opposite effect, creating compliance costs (all the costs a company incurs to adhere to the regulation) that can lead to the exit of certain companies from the market.[32]

A study by Jaffe and Palmer (1997) suggests that stimulating domestic innovation has a positive effect on domestic firms. They found that environmental compliance costs have a significant positive effect on R&D expenditures. However, they found little evidence that the inventive output of industries (as measured by successful patent applications) is related to compliance costs.[33]

On the other hand, Bellas found that, in the energy sector, command-and-control regulation, which is stricter because both the quantity and process of production are regulated, is not conducive to innovation. In 2005, however, he found that a tradable permit system (where entities can trade emission permits among each other and allows

[32] Bergek, Ana. (2014). "The impact of environmental policy instruments on innovation: A review of energy and automotive industry studies". Available at: https://bit.ly/3yD1beW

[33] Faffe and Palmer. (1997). "Environmental Regulation and Innovation: A Panel Data Study". Available at: https://bit.ly/3PoMuDl

flexibility in how emissions reductions are achieved), which is more flexible and incentive-based, performed better in terms of innovation incentives.[34]

Meanwhile, labor regulation can also influence a firm's rate of innovation. Greater restrictions and responsibilities increase costs, which negatively affects innovation, while more flexible regulation can have positive effects on research and development.

Bassanini and Ernst (2002) also found that there is a positive correlation between the level of R&D intensity and labor market flexibility for countries with a decentralized wage bargaining regime. In contrast, this correlation is negative for countries with a strongly coordinated and centralized industrial relations system.[35] This is attributed to industries with production constraints, process innovation can lead to a reduction in the labor force; and if regulation hinders the process of employment adjustments, innovation is discouraged. If there is flexibility in labor adjustment, the cost of compliance with labor regulations becomes lower.

Industries with more regulations and labor protections have less incentive to innovate. Investing in new technologies has a risk, and within this regulation it is more difficult to fire workers, which implies a higher cost in case of failure and lower income in case of success. Bartelsman (2011) found, from a study of 30 industries in OECD countries, that high-risk innovative sectors are lower in countries with strict employment protection legislation.[36]

This suggests that social and administrative regulations can generate both positive and negative impacts on innovation. Both experience and theory show that well-implemented regulation can increase incentives to innovate, while more restrictive regulation has the opposite effect.

A great similarity can be observed with what Aghion mentioned about the relationship between competition and innovation. It can be concluded that the same happens with the relationship between regulation and innovation, resulting in an inverted U-shaped relationship, where regulation can translate into an increase in innovation, but if such regulation becomes too restrictive, this will decrease the level of innovation intensity.

[34] Bellas, Allen. (2005). "Technological Change for Sulfur Dioxide Scrubbers under Market-Based Regulation". Available at: https://bit.ly/3uHtqIB

[35] Bassanini and Ernst. (2002). "Labour Market Institutions, Product Market Regulation, and Innovation". Available at: https://bit.ly/3xdBEIM

[36] Bartelsman, Eric. (2011). "Employment Protection, Technology Choice, and Worker Allocation". Available at: https://bit.ly/3yCrDp8

3) Some Cases in Mexico

This section will analyze some technical regulations designed (approved or in discussion) by the Mexican telecommunications regulator, the Instituto Federal de Telecomunicaciones (IFT by its acronym in Spanish) whose regulatory purposes are limited to the telecommunications and broadcasting sector.

According to the Roadmap 2021-2025, this agency's objectives are based on promoting the development of the infrastructure that facilitates digital development, promoting economic competition, promoting the adoption of new technologies, strengthening users' rights, as well as strengthening institutional innovation.[37] Among these objectives, the promotion of competition and innovation stand out. However, in many cases both objectives become mutually exclusive due to mismanagement or regulatory malpractice.

A series of provisions and drafts that could affect innovation or competition are analyzed. These technical provisions address several issues in the IT sector, but by trying to fix them, other issues may emerge.

A) Technical Disposition IFT-012-2019

In 2020, the IFT issued the Technical Provision IFT-012-2019 which establishes technical specifications for compliance with the maximum limits of non-ionizing radioelectric emissions of products, equipment, or devices to be connected to a telecommunications network and/or make use of the radioelectric spectrum. This provision took into effect one year after its publication in the Official Gazette in 2020.

This provision mandates that ICT devices worn close to the head or body must comply with the basic limits of exposure of non-ionizing radioelectric emissions (in the frequency range of 300 MHz to 6 GHz for those close to the head, and 30 MHz to 6 GHz for those close to body).[38] Basic limits for maximum exposure are based on those established by the International Commission on Non-Ionizing Radiation Protection (ICNIRP).

For this purpose, test methods were established to evaluate whether devices comply with the referred limits. The measurement system to be implemented will be SAR (Specific Absorption Rate) while the testing methods were to be performed by accredited and authorized testing laboratories and certification bodies.[39]

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[37] IFT. (2022). "Objetivos Institucionales". Available at: https://bit.ly/3NLSjKx

[38] IFT. (2019). "Disposición Técnica IFT-012-2019". Available at: https://bit.ly/3SE4EDo

[39] *Ídem*.

This regulation should have been carefully designed and implemented since there is still a limitation in the capacity of laboratories to perform these tests, which may delay the introduction of new ICT products and technologies. This could directly affect innovation because waiting times to certify new products may take longer, affecting the revenue to introduce new products.

As with any regulation, one of the biggest challenges is keeping pace with technological change. In this regard, by the time the regulation was published and came into effect, new technologies for SAR testing were already in place.

The main concern that arises is the lack of local laboratories offering testing services.[40] Therefore, a provisional certificate is suggested pending SAR test results to avoid delays in the introduction of new ICT products and technologies to Mexican users. In this manner, there would be no delays and disincentives to seek new technologies are eliminated.

This provision is an example of a necessary regulation to protect people from health hazards that requires careful application (increase laboratory tests capacity and provision of provisional certificates) to avoid innovation inhibition and to allow people to enjoy the benefits of innovation.

B) Agreement modifying Conformity Assessment Procedure (CAP) in Telecommunications and Broadcasting

Another interesting case for Telecommunications and Broadcasting is the CAP Agreement issued by the IFT in 2020.

This provision was published to simplify and streamline the process of conformity assessment for telecommunications and broadcasting products, so it is easier to provide evidence to the IFT of the correct operation of communication terminals. This is done so certification bodies, testing laboratories and verification units would carry out such conformity assessment in accordance with technical regulations that contemplate technological evolution according to international standards and best practices.[41]

[40] ITI. (2021) "Comentarios de ITI sobre ACUERDO mediante el cual el Pleno del Instituto Federal de Telecomunicaciones expide la Disposición Técnica IFT-012-2019".

[41] IFT. (2020). "ACUERDO mediante el cual el Pleno del Instituto Federal de Telecomunicaciones expide el Procedimiento de evaluación de la conformidad en materia de telecomunicaciones y radiodifusión." Available at: https://bit.ly/3QAgcpn

Such publication generated many disagreements from relevant actors in the sector, who felt that the procedure threatened innovation. In response to this, IFT published a corresponding modification in December 2021.[42]

Main concerns from the industry

Non-transferability of the Conformity Certificates	Test Report sent to the IFT	Certification Scheme Sample per Product Model and Surveillance for more than one Batch	Number of samples per Certification Scheme	Inclusion of non-new products in the Sample Certification Scheme per Product Model for a single Batch
Causes concern because applying the CAP may cause an increase in costs and time to comply with the established	**Causes concern because** it forces to share confidential information	**Causes concern because** laboratory tests must be carried out for each extension of the Certificate of Conformity with a new batch of product of the same brand and model	**Causes concern since** requesting two copies may make the process more difficult	**Causes concern since** the certification of used products is not allowed, they may enter the country without passing these processes and encourage the entry of non-new products of lower quality

Source: AGREEMENT whereby the Plenary of the Federal Telecommunications Institute modifies the Conformity Assessment Procedure for telecommunications and broadcasting.

The IFT modifications have addressed several of the concerns highlighted in the figure above. The regulatory authority has made notable changes, including a reduction in the number of samples required for initial certification and surveillance, increased flexibility in certificate transferability, and the incorporation of non-new devices into the certification framework.

However, while it is crucial for regulatory authorities to prevent low-quality products from reaching consumers, some concerns remain even after the modification of the provision discussed in this section, and still impose overly burdensome restrictions that punish manufacturers and hinder importers.

[42] IFT. (2021). "ACUERDO mediante el cual el Pleno del Instituto Federal de Telecomunicaciones modifica el Procedimiento de evaluación de la conformidad en materia de telecomunicaciones y radiodifusión". Available at: https://bit.ly/3BXkyCL

While the requirement for laboratories to immediately share test reports with the IFT has been made more flexible, it still carries the potential risk of exposing sensitive intellectual property information when the regulatory agency requests the reports. Furthermore, for manufacturers or importers seeking an extension of their Conformity Certificate for an additional batch of devices with the same brand and model, a bureaucratic procedure continues to be in effect creating additional delays and costs to introduce devices into the Mexican market.

Because of this, there were proposed additional suggestions to further improve the ease of doing business in Mexico under the CAP:[43]

1. Allow laboratories to determine the number of samples required for testing.
2. Grant approval based on test reports issued by foreign accredited laboratories.
3. Eliminate any bureaucratic procedure for certificating extra batches of devices with the same brand and model.
4. Eliminate any provision that puts at risk intellectual property by sharing unnecessary information about devices.

These suggestions along with others intend that time and complications of the CAP are minimized, thus encouraging the continuity of research and development of new technologies.

All of the above suggests that, although there is a clear need for a CAP to improve the quality of goods in the short and medium term in the telecommunications sector, bad quality regulation may create disincentives to continue innovating or democratizing the benefits from innovation, which in the long term would further diminish the quality of goods in the telecommunications market. This implies that regulation to guarantee the quality of goods may have the opposite effect to that desired, at least in the long term.

C) AGREEMENT WHEREBY THE GOODS WHOSE IMPORTS AND EXPORTS ARE SUBJECT TO ENVIRONMENTAL AUTHORITIES

A third example on how regulation can affect innovation in Mexico is the agreement that establishes the goods whose import and export is subject to regulation by the Ministry of the Environment and Natural Resources (SEMARNAT). In such an agreement, SEMARNAT decides which residual products may be exported and imported according to determined categories. Its purpose is to protect the environment by avoiding products that may constitute pollutants. This provision was published in the DOF in December 2020.

[43] ITI. (2021). "Comentarios de la ITI sobre el Anteproyecto de Acuerdo mediante el cual el Pleno del Instituto Federal de Telecomunicaciones modifica el Procedimiento de evaluación de la conformidad en materia de telecomunicaciones y radiodifusión (MEX/496)".

The issue was that this regulation categorized electronic devices that are unusable but can be repaired as hazardous waste.

The new categorization hindered the export and import processes, as it made impossible to continue with the exchange of electronic equipment for repair, which impacts telecommunications users and prevents the fulfillment of warranty and repair service contracts. Many of these are sent abroad for repair and sent back to Mexico, the new category prevents this process, as hazardous waste cannot be exported.

According to the Basel Convention, and even the legislation in Mexico, electronic equipment sent for repair or reconditioning should not be categorized as "waste". The new categorization hindered the export and import processes; since the entry into force of this regulation, it was impossible to continue with the exchange of electronic equipment for repair.[44] For that reason, this classification was corrected in October 2022, when the category was changed to "hazardous wastes that are not recyclable" to exclude ICT devices that could be repaired.

This is an example of how a non-economic regulation can affect the market. The literature shows that environmental regulation usually has positive impacts on innovation by creating incentives for the development of new ecological and technological processes. However, poor implementation can lead to increased costs or, as in this case, barriers to trade.

D) Technical Disposition IFT-011-2017

Finally, the last case is the Technical Provision IFT-011-2017: specifications for mobile terminal equipment that make use of the radio spectrum or be connected to telecommunications networks. The provision has three parts, issued in the Official Gazette in 2017 and 2018, that address different problems where a regulation was necessary for its solution:

1) The first part presents an Equipment Manufacturing Identity Code (EMIC) and FM sound broadcasting receiver functionality. There were no specifications for three topics: the first one regarding the Equipment Manufacturing Identity Code (EMIC) so that the Mobile Terminal Equipment can be unequivocally identified and blocked when there is a report of theft or loss. The second one regarding the requirement to avoid blocking the FM radio broadcasting receiver functionality of Mobile Terminal Equipment that may use the radio electric spectrum or be connected to telecommunications networks (users may enjoy free broadcasting content and receive alerts in the event of emergencies or

[44] CANIETI. (2021). "Acuerdo que establece las mercancías cuya importación y exportación está sujeta a regulación por parte de la SEMARNAT". Available at: https://bit.ly/3JJnPYu

disasters), and the third one regarding the test methods to verify compliance with such specifications and requirements. With this provision, these three specifications are now in place.[45]

2) The second part, Mobile Terminal Equipment operating in the 700 MHz, 800 MHz, 850 MHz, 1900 MHz, 1700 MHz/2100 MHz and/or 2500 MHz bands. This part was created to establish technical requirements for other frequency bands of operation in the national territory and to provide for the conformity assessment of Mobile Terminal Equipment, since NOM-081-SCT1-1993 only establishes the minimum technical requirements to standardize the compatibility of mobile radiotelephony systems with cellular technology in the 800 MHz band, not the other bands.[46]
3) The third part seeks the existence of a Cellular Broadcasting Service (CBS) for the notification of risk or emergency situations. The most representative technical barrier for the dissemination of alert messages through the Cellular Broadcasting Service (CBS) technology is not the implementation itself, but the low or null availability of Mobile Terminal Equipment compatible with the technology. The IFT made this provision to establish the technical specifications of mobile terminal equipment that can make use of the radio spectrum or be connected to telecommunications networks, in case of receiving alert messages for the notification of risk or emergency situations, through the cellular broadcasting service; as well as the test methods to demonstrate compliance with such specifications.[47]

Among the main concerns of this provision are possible violations to the United States-Mexico-Canada Agreement (USMCA). The proposed disposition does not present any evidence or technical information regarding the implications of compliance with mandatory VoLTE (Voice Over LTE) functionality, which allows voice calls to be made over a 4G network. In addition, the proposed technical regulation does not conform to any international standard.

[45] IFT. (2017). "Disposición Técnica IFT-011-2017: Especificaciones de los equipos terminales móviles que puedan hacer uso del espectro radioeléctrico o ser conectados a redes de telecomunicaciones. Parte 1. Código de Identidad de Fabricación del Equipo (IMEI) y funcionalidad de receptor de radiodifusión sonora en Frecuencia Modulada (FM)". Available at: https://bit.ly/3vXDAFn

[46] IFT. (2017). "Disposición Técnica IFT-011-2017: Especificaciones técnicas de los equipos terminales móviles que puedan hacer uso del espectro radioeléctrico o ser conectados a redes de telecomunicaciones. Parte 2. Equipos terminales móviles que operan en las bandas de 700 MHz, 800 MHz, 850 MHz, 1900 MHz, 1700 MHz/2100 MHz y/o 2500 MHz". Available at: https://bit.ly/3QC6Bio

[47] IFT. (2021). "Disposición Técnica IFT-011-2021: Especificaciones Técnicas de los Equipos Terminales Móviles. Parte 3. Servicio de Radiodifusión Celular para la notificación de riesgo o situaciones de emergencia". Available at: https://bit.ly/3BTya1V

The objective of this regulation is to create a legal framework to know how mobile terminal equipment can make use of the radio spectrum and thus give more certainty and clarity to consumers about the equipment they use. However, these are technologies that evolve at a faster pace than regulation, which often makes the provisions created by regulatory bodies obsolete. Delayed or incomplete regulation can create obstacles to the creation of new technologies, which affects markets and consumers in the long term. Furthermore, these obstacles can affect the rent of firms, as well as eliminating the incentives to innovate, since it is costly, and less rent implies more risk when investing in new technologies.

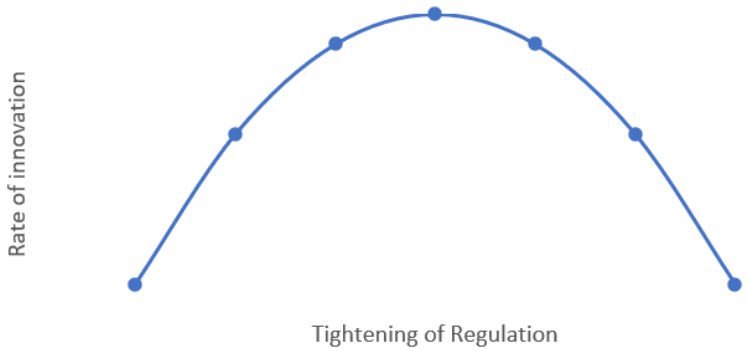
Also, violations of the USMCA may imply complications in the country's imports and exports, decreasing international trade and directly affecting the sale and production of products in the market. This would decrease the firm's returns, leading to less spending on innovation.

4) Final Remarks and Recommendations

Having reviewed and analyzed how many regulatory aspects may prevent innovation, some general conclusions are:

- Even though regulation is desirable when facing a market failure (monopolies, externalities, or other type of inefficiencies that affect competition), it could create other problems that affect, directly or indirectly, innovation and how consumers benefit from it.
- Every type of regulation the government implements (economic, social, administrative, or technical) has the potential to affect innovation when execution instruments are poorly implemented, or it is too strict.
    - A poorly implemented competition policy can reduce revenues for innovative agents.
    - Badly designed antitrust regulations may reduce incentives for entrant firms to innovate.
    - Regarding price regulation, price caps also reduce incentives to innovate.
    - Environmental and labor regulation may create compliance costs that can lead to the exit of certain companies such as SMEs from the market.
    - Technical regulation may create standards that lower the efficiency of production or create trade barriers, both affecting firms' willingness to innovate.
- Even though regulation is normally recommended, tight regulatory framework may cause other failures in the market. There seems to be an effect of regulation to innovation in the shape of an inverted U, where lenient regulations have a positive effect, but stricter regulations start to create the opposite effect.

Effect of regulation on innovation



Source: Elaborated by The CIU.

- Mexican cases show how the development of standards to regulate certain aspects of a market can cause incentives to slow down or stop innovation processes.
- Delayed or incomplete regulation can create obstacles to the creation of new technologies by imposing compliance costs, which affects markets and consumers in the long term.

Furthermore, the following recommendations are suggested:

- Regulators and federal authorities should establish continuous public-private collaboration worktables where regulatory and industry concerns can be discussed.
- Modifications to the Federal Telecommunications Law need to be considered where new innovative regulatory schemes such as sandboxes are considered.
- In the USMCA framework, existing Mutual Recognition Agreements for ICT devices between de Government of Mexico and Governments of U.S. and Canada must be implemented.
- Communication and coordination between regulators and federal ministries need to be strengthened (e.g., IFT and Ministry of Economy).
- Continuous mandatory training on WTO Technical Barriers to Trade Agreement for regulatory and federal authorities should be implemented.
- Best international regulatory practices and collaborative schemes should be considered, considering Mexico's market conditions.
- Regulation regarding Conformity Assessment Procedures and approval must be carefully developed and executed. Complex or unnecessary requirements increase costs to producers and importers which can be reflected in ICT products' prices to the detriment of consumers.
- Regulatory agencies and federal authorities should encourage and facilitate the setting up of new testing labs and certification bodies to open competition.

- The scarcity of testing labs may delay the introduction of new ICT products and technologies. Waiting times to test and certify new products may take longer, affecting the willingness to introduce innovative products, and thus, avoiding people from enjoying innovation.
- Regulatory agencies must ensure that low quality goods do not reach the hands of customers. However, an excessively burdensome regulation for that purpose may punish manufacturers and inhibit importers, resulting in an inefficient solution to the problem.
- Environmental and health regulation regarding ICT devices needs to be carefully drafted and follow a proper public consultation where industry concerns should be listened.

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