Mexico's Shared Spectrum Model

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Abstract

Mexico, as mandated by a recent constitutional amendment, is in the process of creating a wireless broadband wholesale network using all the spectrum in the digital dividend (700 MHz band). The decision was based on the economics behind it, as it would significantly reduce costs in the market. It is aimed at making a more efficient use of the spectrum, reduce the cost of providing service, substantially reduce barriers to entry, and change the current market structure, which is highly concentrated. The government is working towards assigning the rollout and operation to a private-public partnership before the end of 2014 so that it can be fully operational before 2018, as established by law. This paper explains the rationale behind this controversial decision and explains alternative approaches to those decisions that are still being debated.

Introduction

Spectrum sharing is a loosely used term. In its broadest sense, it encompasses any sharing of the infrastructure used by systems that utilize spectrum. More commonly, the definition refers to multiple wireless systems that operate in the same frequency band. Several dimensions are used to characterize spectrum sharing: administrative, technical, market-based, time, space, and geography. In the end, spectrum sharing, in any of its forms, is related to its scarcity and ample demand for it.

This paper reviews some of the aspects of spectrum sharing that are relevant to Mexico's recent decision to implement one specific form of such sharing. Mexico is in the process of drafting the details of a model which has not been so far tried anywhere of the world. Whenever appropriate, this country's standing is compared to its peers in Latin America.

1. Scarcity of spectrum

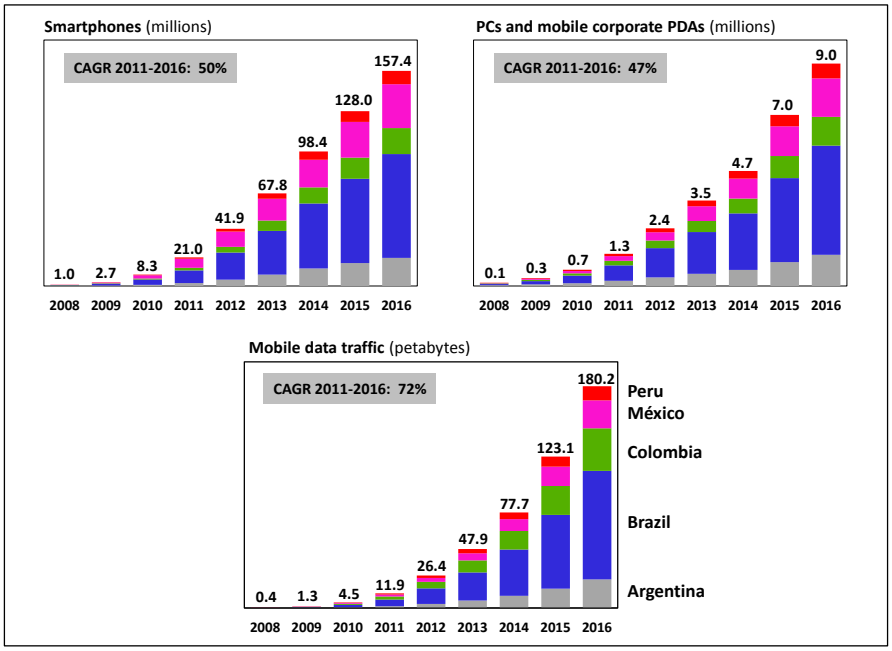
Scarcity of spectrum arises from three different sources (Foster, 2008): demand, administrative processes, and technical issues. Significant progress has been made in Latin America to try to alleviate spectrum scarcity, but much remains to be done.

1.1 Sources of scarcity

1.1.1 Demand: The most important source of scarcity arises from the demand for new services that require spectrum (Foster, 2008). To illustrate this point, we can take the mobile data market. The number of smartphones in Latin America is expected to grow from 67.8 million in 2013 to 157.4 in 2016, whereas PCs and mobile corporate PDAs will increase 5.5 million to reach 9 million. These devices will require infrastructure that will support the transmission of 180 petabytes by 2016, putting

a strain not only in operators that will need to significantly invest to deploy last-generation networks but also on the amount of spectrum required (Figure 1).

Figure 1.
Wireless services demand forecast (2008-2016)



Source: Katz & Flores-Roux (2011)

Forecasting this situation long in advance, in 2006 the International Telecommunication Union (ITU) estimated the required spectrum for the development of mobile communications (IMT-International Mobile Telecommunications). Depending on the type of market, by the year 2020, it anticipated that there would be a need for 1,280 to 1,720 MHz to be allocated to these services (see Table 1).

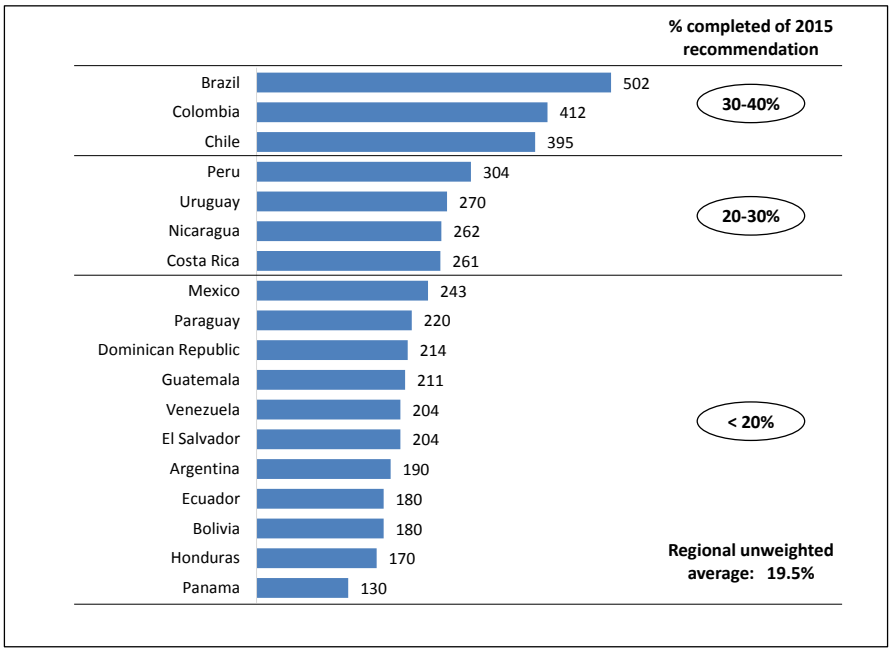
Table 1.
ITU recommended spectrum allocations of IMT technologies (in MHz)

Market setting	Pre-IMT, IMT-2000 and enhancements			IMT-Advanced			**Total spectrum requirement**		
Year	2010	2015	2020	2010	2015	2020	**2010**	**2015**	**2020**
Low demand scenario	760	800	800	0	500	480	**760**	**1,300**	**1,280**
High demand scenario	840	880	880	0	420	840	**840**	**1,300**	**1,720**

Source: Report ITU-R M.2078

Using the 2015 recommendation as a benchmark, it can be observed that Latin America is far from reaching 1,300 MHz of assigned spectrum to IMT. Brazil has gone the furthest, having licensed 500 MHz nationwide to private wireless players (see Figure 2).

Figure 2.
Assigned spectrum in Latin America (in MHz, mid 2013)



Source: Signals Telecom Consulting / 4G Americas

1.1.2 Administrative processes: The second source of scarcity arises from administrative processes for determining spectrum use, changes in allocations, refarming, and even revocation of licenses. These processes are long and time consuming, and sometimes even abused by players – either service providers or regulators – to increase the value of spectrum holdings, at least temporarily. This is a form of artificial scarcity, which limits essential resources that hinder entrance and competition; it also has relevant negative effects on costs and quality. In Latin America, the transition to digital television and the analogue switch-off is a point in case (as explained later).

The licensing scheme still suffers from important legacy issues from the old system of command and control. Most of the licenses have relevant limitations to the types of services that can be offered; some of the existing restrictions can even be considered non-technologically neutral. Most of the countries still have spectrum caps, though these are revised frequently, especially when additional spectrum is put up for grabs. A majority of licenses in Latin America are subject to annual on-going payments; these payments are equivalent to taxes that trickle down to end-user prices. Except for Guatemala and El Salvador, there is no clear definition and regulation of a secondary spectrum market that would add flexibility to the market and that would allow a scarce resource to be channeled to where it is most valuable.

1.1.3 Technical issues: The third source or scarcity is created by technical issues, such as the type of installed equipment, technology, and radio-planning requirements. For example, many countries in Latin America still have iDEN[1] networks running; Sprint USA switched off this network in 2013.

[1] Integrated digital enhanced network, which provides both trunking services and traditional mobile communications. It was first released in 1994. In Latin American markets, its distinct feature has been its "push-to-talk" service.

Others have fragmented the spectrum in such a way that only certain types of networks can be deployed; the best example is the APT and US Plan segmentation of the 700 MHz band.

1.2 Progress in Latin America

Most countries in the region have partially dealt with these issues. In the last two years alone, governments in the region have auctioned 790 MHz[2] for IMT services, increasing available spectrum by 21%, but only moving the regional average to reach the ITU's recommendations from 16% to 19.5%.

More spectrum will become available once the 700 MHz band, known as the "digital dividend," gets assigned to wireless players. Freeing up this spectrum, which is currently being used for broadcasting transmissions, provides a good example of how Latin America is approaching the three forms of spectrum scarcity.

As late as 2011, most Latin American countries still had the 700 MHz spectrum band allocated to broadcasting services. In the last two years, most countries reaollcated the spectrum, on a primary basis[3], to IMT services; they have also opted for the Asia-Pacific Telecommunity (APT) band plan, making full use of 90 MHz in this band possible[4]. Some countries have already assigned this spectrum to operators. Chile recently (February 2014) assigned 70 MHz of this spectrum to three operators, even before the completion of the analogue switch-off[5].

It is important to mention that the analogue broadcasting switch-off, which frees the 700 MHz and allows for the first steps to proceed towards analyzing the benefits of the "second digital dividend" (600 MHz) will not be completed in the region before 2024 (see Table 2).

As a side comment regarding the transition to digital television and which illustrates the heftiness of state intervention in spectrum related matters, it is important to mention that the region as a whole has had significant trouble setting the standard for the transmission of digital television. Mexico, one of the first ones to choose a standard, decided to use ATSC, following Canada and the United States. Brazil debated the issue for several years, opting for a modified version of the Japanese standard (ISDB-T) in 2006; after this decision, the country spent time and resources to promote its standard in the region, claiming large economies of scale given by the relative size of its economy[6]. Eventually, almost all countries in South and Central America adopted, in some cases reverting previous decisions (e.g., Honduras). Only Mexico, El Salvador (ATSC), Colombia and Panama (DVB-T, European standard) have opted for different standards.

[2] Simple sum of the MHz auctioned in each country.

[3] "Allocation" refers to the use given to spectrum bands by countries. This information is codified in "frequency allocation tables".

[4] As opposed to the US plan, which reserves 2 blocks of 12 MHz for a public safety network

[5] Channel 54 (710-716 MHz) in Santiago and Channel 57 (728-734 MHz) in Valparaíso, which will be switched off at a later date, under responsibility of the winner

[6] Brazil also had a system of its own for the transmission of analogue television. PAL-M is a modified version of the PAL European standard. No other country adopted this standard and Brazil was left with sub-economies of scale; to receive the broadcast signal, any television set not made in Brazil required a transcoder

Table 2.
Analogue switch-off timetable in Latin America (as of January 2014[7])

	Date standard was chose	**Analogue switch-off**
Argentina	August 2009	2019
Bolivia	May 2010	2020
Brazil	June 2006	2016
Chile	September 2009	2017
Colombia	August 2008	2018
Costa Rica	April 2010	Between 2016 and 2020
Dominican Republic	August 2010	2015
Ecuador	March 2010	2018
El Salvador	April 2009	2015
Guatemala	May 2013	2018
Honduras	September 2013	2018
Nicaragua	August 2010	Not defined
Mexico	July 2004	2015
Panama	May 2009	2017
Paraguay	June 2010	2023
Peru	February 2009	2024
Uruguay	August 2007	2015
Venezuela	September 2009	2020

Source: Aegis (2010), Katz & Flores-Roux (2011), press clippings

From a regional perspective, there seems to be a tendency towards the liberalization of the spectrum market, but it is noteworthy that many recent decisions point in the opposite direction. Even though it is well known for its market-friendly policies in most of its economy, Chile now assigns spectrum through a "beauty contest" instead of an auction process, where monetary offers only enter into consideration after a strict selection process based on coverage, investment, and other technical requirements. In 2013, Colombia auctioned spectrum considering, as one of several variables, the number of tablets offered.

More radically, several countries (Argentina, Bolivia, Costa Rica, Ecuador, Honduras, Paraguay, Uruguay, and Venezuela) have opted for direct licensing of spectrum, mostly to state-owned operators. In some cases, such as Uruguay and Costa Rica, where the state-owned companies compete in the market through a (mostly) competitive neutral environment, this poses no threat to the existence of a market-based approach to telecommunications. In the other cases, up to a certain degree, these direct assignments correspond to an effort to move into giving the State a more active role in the provision of telecommunications services.

This last statement can be exemplified by a practice that has been even more widespread in the region. The lack of transport infrastructure (backbone), which covers localities where just over 50% of the region's population lives, has been a worry to authorities, as no real broadband can be provided if there is no transport capacity. The issue has been addressed by promoting state-owned companies (e.g., Telebrás in Brazil, CFE in Mexico, Arsat in Argentina) to build fiber-optic networks outside profitable areas. Other countries have opted for a subsidy scheme, where the government covers an important part of investment and operating costs (e.g., Azteca in Colombia and Peru). The return of

[7] Many countries have changed their analogue switch-off date. For example, Mexico has announced four different dates in the last eight years. The most recent one, mandated in the constitutional amendment of 2013, sets December 31, 2015 as the last of analogue transmissions in the country.

the State to the provision of telecommunications services seems a change of direction form a purely liberal model to a mixed private-public model.

On technical sources of spectrum scarcity, most countries have added technological neutrality clauses to their regulatory frameworks, but these rules take time to permeate through the market and, in essence, only affect the deployment of new infrastructure. Many still require approval of radio-planning and base station deployment (e.g., Brazil), thus creating a barrier for speedy deployment. In addition, significant zoning rules (at the federal, state, and local levels) hamper the expansion of networks. NIMBY[8] activism is becoming more widespread in the region; some countries (Chile[9], Colombia[10]) have issued, or are in the process of issuing, regulations on these matters. Though in many senses desirable, these new regulations will become a bottleneck to the deployment of networks; they will, though, promote infrastructure sharing, which has been given a boost as of lately.

2. Some basic aspects of spectrum sharing

As the need of spectrum increases, and regulators and standards authorities struggle to find more of it in a crowded space, spectrum sharing – the possibility of the same spectrum being used by more than one user – has become an enticing idea. Future mobile telecommunications systems will most likely have to share their spectrum and coexist in a more efficient manner.

Not considering passive sharing of infrastructure (mostly, co-location and sharing of towers and sites), all types of spectrum sharing involve more than one wireless communications system leveraging the same band without causing interference to the other users. According to a study in Europe (Werbach & Mehta, 2014), the average occupancy rate for a dedicated band was below 10% of the band's capacity. As concerns over spectrum scarcity increase, sharing is believe to become the norm in the future.

Traditional spectrum licensing, where a certain band is given in exclusivity to a certain player, creates certain problems that have become evident as demand for wireless data, and hence, for spectrum, has grown substantially in the last few years. As has been clear in almost every country when trying to clean up the digital dividend (700 MHz in Latin America and Asia, 800 MHz in Europe), reallocating the spectrum is slow, expensive, uncertain, and legally contentious. Unrestricted auctions artificially favor large, incumbent providers and certain business models; regulators have forced the entry of new players both by imposing caps and by reserving bands for new entrants. Auctions also create incentives for anticompetitive behavior. If not forbidden, large incumbents usually try to acquire as much spectrum as possible to warehouse for potential future needs or to prevent potential competition. This goes against spectrum efficiency, but is makes economic sense for established players.

Spectrum sharing, in any of its forms, increases spectrum supply. Thus, it provides greater access to a scarce resource. It reduces barriers for those requiring operators, which translates into more competition. Sharing involves a process of continual reallocation, including even reallocation to

[8] "Not in my backyard", used to express opposition by local citizens to the locating in their neighborhood of a civic project, that, though needed by the larger community, is considered unsightly, dangerous, or likely to lead to decreased property values (Oxford English Language Dictionary)

[9] Ley Nº 20.599, June 11, 2012, "Ley de Torres"

[10] In December 2012, the Constitutional Court ordered the Ministry of ICT (Mintic) to create mechanisms to regulate the distance between radio base stations and houses, schools, hospitals, and other urban deployments.

different services, such as data and broadcasting. Needless to say, if well implemented, sharing reduces waste and increases efficiency.

One of the largest critics to spectrum sharing is the limitations to manage interference between different users; this is the main reason why spectrum has traditionally been licensed for exclusive use. It is often mentioned that, absent usage rules, sharing can lead to the "tragedy of the commons," whereby increasing the number of users results in lower quality of service for everyone.

Technological advances (e.g., cognitive radios, which are designed to be able to use several spectrum channels), regulation (e.g., rules of "etiquette" and cooperative approaches that govern common usage), and economic incentives (pricing and penalties) are helping alleviate most of the existing concerns. There is still a long road ahead, but spectrum sharing promises to ease the existing spectrum crunch.

Mexico has opted for a basic spectrum sharing model, which, though very simple conceptually has not been tried before. A wireless wholesale network will be built on the 700 MHz; operators with or without infrastructure will then lease capacity from it, technically similar to traditional MVNO and roaming agreements.

As opposed to previous trials of the same idea, the spectrum allocated to the wholesaler in Mexico is of prime quality., LightSquared in the United States, which would have used the L-band, between 1,525 and 1,646.5 MHz. it filed for bankruptcy in May 2012 as the FCC barred it to provide service because there were potential interference issues that had not been resolved. Yota in Russia also studied and began implementing the model in the 2.5 GHz band. Aero2 in Poland, together with CenterNet started deploying a wholesale network in the 1.8 GHz band. MVS in Mexico announced, back in 2009, the creation of a similar wholesaler also in the 2.5 GHz; their plans have been put to rest as their licenses expired and the government only renewed 60 MHz in September 2013.

3. Mexico: Background

3.1 Performance of Mexico's telecommunications sector

Mexico, in many aspects a vibrant economy (see Box 1), has had, for most of the last two decades, a lackluster telecommunications sector. The OECD (2012) even called it "dysfunctional" and attributed to its underperformance an estimated cost, in welfare loss, of USD 129.2 (2005-2009), or 1.8% of GDP per annum. It suffices to compare mobile penetration with the rest of Latin America to realize, without any further research or facts, that something is nor working properly. Of the 19 countries in the region, only Cuba has fewer mobile subscriptions per 100 inhabitants than Mexico (see Figure 3), even though it is home to the largest telecommunications company in the region and one of the top ten in the world.

With Mexico having the fifth highest GDP per capita (PPP) in the region, only 15% lower than the highest (Chile), it can be stated with certainty that the telecommunications regulatory framework has not served the country. According to the OECD, who wrote a report on Mexico's telecommunications sector in 2011-2012, there were two high level causes: a bad institutional set-up and lack of competition (see Box 2), citing that one of the main barriers to competition was that decisions are either not enforced of suspended by the courts.

Box 1.

Mexico in a snapshot

Mexico, an upper-middle income country in North and Central America, is the largest Spanish speaking country in the world and accounts for around 25% of economic activity of Latin America, as measured by GDP. It is a market-driven economy, with exports accounting for 33% of GDP, mostly in the manufacturing and oil industries. It has signed tens of free trade agreements, being the North American Free Trade Agreement (NAFTA), with Canada and the United States, the most important one. These two countries accounted for 69.2% of trading activity in 2012. Like the rest of Latin America, Mexico is a country with high inequality, as measured by the Gini Index; 53.3 million people (45.5%) live in poverty conditions; 11.5 million (9.8%) live in extreme poverty. (CONEVAL, 2013)

Table A

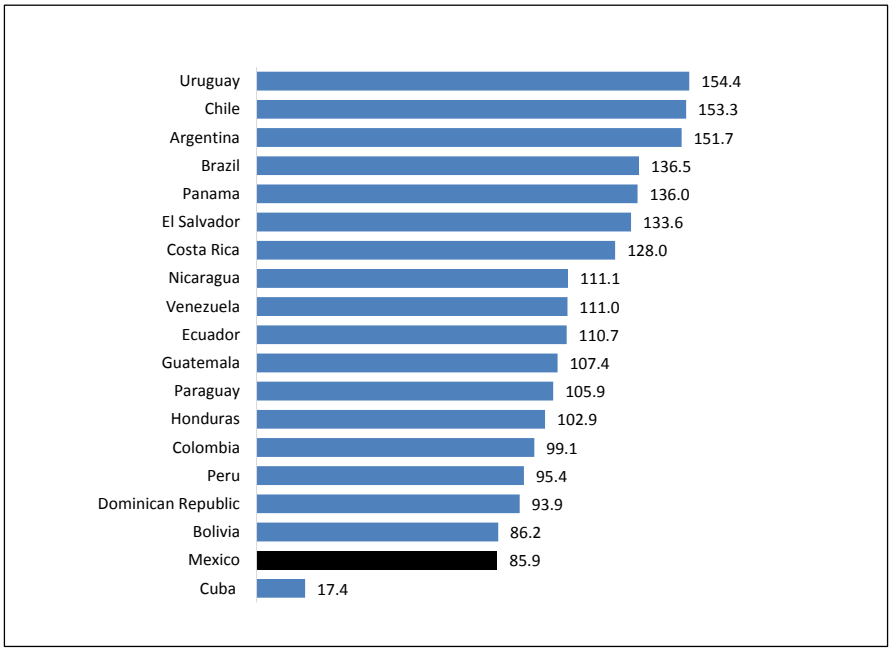
Mexico and India: Basic statistics

	Mexico	India
Population (2012, million)	120	1,210
Area (square kilometers)	1.97	3.27
GDP (2012, trillion USD)	1.33	1.75
GDP per capita (2012, USD)	11,224	1,389
GDP per capita (2012, USD PPP)	15,608	4,209
Gini index (2010)	47.2	33.9

Source: International Monetary Fund, World Bank

Figure 3.

Mobile penetration in Latin America (December 2013)



Source: GSMA Intelligence (2014)

Box 2.
The Mexican telecommunications sector

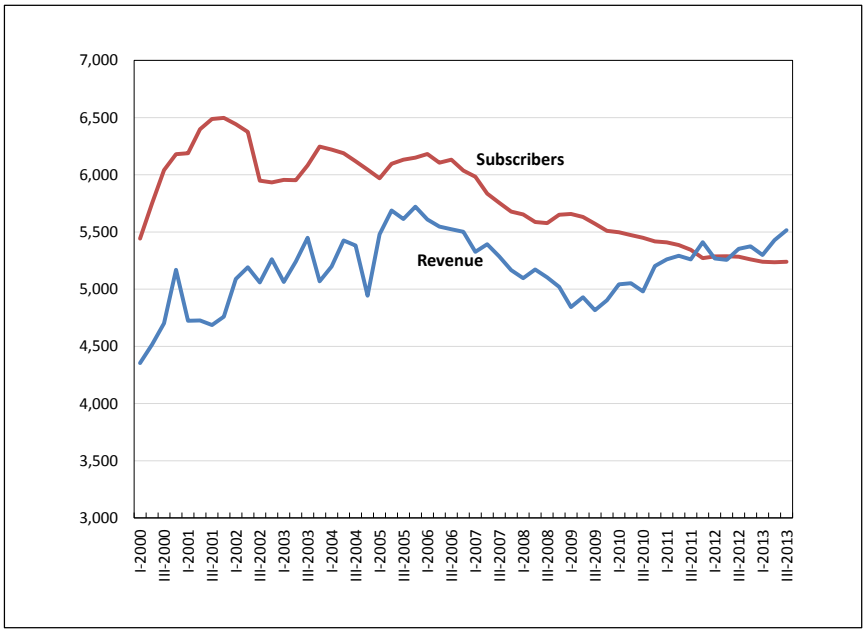
Mexico started reforming its telecommunications sector back in 1990 when it privatized Telmex, the state-owned monopoly provider. As significant investment was required at the time to eliminate pent-up demand, improve quality of service, and rebalance tariffs, the company was given a 5-year monopoly transition period for fixed telephony services. Mobile telecommunications have been open to competition since 1989. In 1995, fixed telephony (local and long distance) was legally open to competition; several new providers entered the space in 1996. Cable operators were not allowed to provide voice services until 2007.

Several companies provide fixed line services, including CLECs and cable operators; as in most countries in the world, the incumbent company Telmex (America Móvil - AMX) is the player with the largest market share (79%). Mobile telecommunications are provided by four companies – Telcel (AMX), Movistar (Telefónica), Iusacell, and Nextel. Telcel, the largest player, has a 70% market share in terms of subscribers. This market structure was transferred to broadband (wireline and wireless), where AMX has a market share above 60%.

Even after almost 20 years of deregulation, the sector remains overwhelmingly concentrated in one provider. AMX, the largest telecommunications company in Latin America, accounts for around 66% of total revenues (OECD, 2012). The next two players – Telefónica (the second largest telco in Latin America) and Televisa (the world's largest broadcaster in Spanish, about the same size as Globo, the Brazilian media company) – capture approximately 7% each. With the regulatory framework in place before the constitutional amendment of 2013, there was little evidence that this situation could change in the future (see Figure 2.A).

Figure 2.A

Evolution of HHI in mobile telephony in Mexico



Source: Author based on GSMA Intelligence (2014)

Total revenues reached an all-time high of USD 29 billion USD in 2012, second only to Brazil in Latin America, which generated USD 100 billion in the same year.

Until 2013, the sector was regulated by both the Comisión Federal de Telecomunications (Federal Telecommunications Commission), an independent technical body, and the Secretaría de Comunicaciones y Transportes (SCT – Ministry of Communications and Transports). As many of their responsibilities overlapped (the so-called "double window"), there was a generalized view that this caused confusion, created arbitrage opportunities for players, and hindered investment and competition (OECD, 2012). As explained in other parts of this text, the recent constitutional reform was partly aimed at tackling this problem.

The report was received with mixed feelings, even though it was the regulator (Comisión Federal de Telecomunicaciones - Cofetel) that requested the OECD to carry out the study. In response, at the event that the OECD presented the report, the SCT presented ten actions[11] that would, if implemented in due time, increase competition in the sector. This event took place only ten months before the change of administration, elections were looming, and the SCT had little time and little clout to implement the measures; very little progress was achieved.

The new president took office in December 2012. He promptly (the second day of his administration) announced the creation of a "Pact for Mexico," an agreement with the other large political parties to quickly reach consensus, so that bold reforms could be in place early on during his term. A long list of 95 commitments, touching every corner of social and economic development, was published. Among them, ten were directly related to the telecommunications sector. Broadband access would become a "human right," the regulatory body would become truly independent, competition would be increased, and a wholesale network on the 700 MHz band would be deployed. This last issue was part of two commitments ("Compromiso 41" and "Compromiso 44").

3.2 The constitutional reform

Many of the commitments, including telecommunications, required changes to the Constitution. As many as ten constitutional amendments were passed by Congress[12] in the first year (2013) of the actual administration. The telecommunications reform was passed in tandem with the competition reform. It brought about radical changes in terms of institutional organization and the State's role in the sector (see Box 3).

Relevant to the topic of this paper is the mandate set forth in Transitory Article 16. The State, through the Executive Power, in coordination with the IFT, must guarantee that a wholesale network using 90 MHz of the digital dividend spectrum is built and fully operational before 2018. This paper refers to this network as "the wholesaler."

[11] Among them, the use of public infrastructure (buildings) to deploy infrastructure, the auction of the 700 MHz band (later reverted by the incoming administration), the freeing up of additional capacity in the state-owned backbone, as well as building an inter-exchange point (IXP) and deploying thousands of community centers (SCT, 2012)

[12] Among them, education, competition, telecommunications, transparency, security, electoral code, energy, financial sector and tax code

Box 3.
Mexico's constitutional reform

The constitutional reform, sent to Congress in March 2013 and approved in June of the same year, is broad and detailed. It adds 2,500 words to a Constitution that only has 75,000, not counting an additional 4,100 words of transitory articles. Some changes (e.g., human rights, the creation of IFT as an institution) clearly have a place in the supreme law, but many of them are regulatory in nature (e.g., asymmetric regulation, the process to select commissioners, the use of the 700 MHz band, the analogue TV switch-off date). It is the opinion of this author that certain aspects would have been better addressed in lower hierarchy legislation, as they are not "constitutional" in their own right, and could possibly need a revision in the short term.

The most important aspects, relevant to the discussion of the present paper, are the following:

- Access to ICT, in particular broadband, is now a human right in Mexico. The State must guarantee access to ICTs, broadcasting, and telecommunications, "including broadband and Internet" (Article 6, Mexico, 2013).
- A constitutionally independent regulator (Instituto Federal de Telecomunicaciones – IFT), replacing Cofetel, was created. This new body would not report to the Executive Power and its decisions could not be temporarily suspended by the Courts.
- The IFT was given ample power to regulate the sector. Not only can It write and enforce ex ante regulation, but it was given the responsibilities which are typical of antitrust commissions. It is in charge of analyzing behavior of competitors, it can develop asymmetric regulation whenever needed, and it can even mandate divestitures.
- IFT is obliged to "regulate participants asymmetrically […] with the objective of eliminating barriers to competition" (Article 27, Mexico, 2013).
- Significant market (dominance) is simplified to "having more than 50%" of market share." IFT was given six months since its inception to declare dominance in the telecommunications and broadcasting sector and impose asymmetric rules.[13]
- The commercial exploitation of the backbone built on the transmission lines of the state-owned electric utility monopoly would be handed over to another state-owned company[14]. This company would be in charge of planning and supervising the backbone expansion (Transitory Article 15, Mexico, 2013).
- The State would guarantee the deployment of a "public shared telecommunications network to promote access to broadband and telecommunications services." It will use all 90 MHz of the 700 MHz band, as well as the state-owned backbone and any other state-owned assets that could facilitate or accelerate its deployment. It would only be allowed to provide service on a wholesale basis (Transitory Article 16, Mexico, 2013).

[13] As of the writing of this paper, it was still being debated whether having 50% market share ought to be interpreted as a one-off measure of significant market power or whether it should become a permanent measure. The date for publishing these measures is set for March 9, 2014.

[14] Telecomunicaciones de México (Telecomm), who is the state-owned monopoly provider of telegraphy services.

4. Mexico's 700 MHz wholesaler

4.1 Historical background

Having included such detailed article in the constitution had its roots on work done during the previous two years by the regulatory body. As it was imminent that the digital dividend would be available in the near term, Cofetel had already started studying different scenarios with the objective of maximizing the benefits of this band. It had hired a large team of external consultants and dedicated significant resources to understand the viability of developing a model that would make efficient use of the spectrum, would promote competition, and would guarantee that a last generation wireless data network capable of supporting high speed were built (LTE).

Several assumptions permeated the thinking process:

- Wholesale cost of smartphones will be at sub-USD 100. This will dramatically improve affordability.
- Spectrum use is significantly more efficient if it is not partitioned into sub-bands. One network built using the whole 90 MHz of available spectrum results in more capacity at a lower cost.
- Licensing the spectrum to private players (two or more) would only preserve the status quo, where Telcel would remain dominant and the other players would have significant trouble competing and surviving.
- Independently of abuse of market power, which arguably Telcel profits from, Telcel's cost structure would be much lower than its competitors'. Even after any consolidation scenario, this would still be the case. Competition would be thus hard to bring about.
- Facilities-based competition would be almost impossible to achieve, as a greenfield wireless network, even using the 700 MHz which requires much fewer sites, would not be cost-competitive with any of the existing networks.
- The regulatory framework, as well as the existing incentives in the marketplace, was very weak to allow the entry of virtual operators (MVNOs). Three had already tried to the dismal of their shareholders.

These assumptions, together with the economics of building a nationwide wireless network and its likely effects in competition, moved the team into the proposal that a year later would find its way into the constitution: use all 90 MHz of the digital dividend to build one wholesale network that would complement incumbents' networks and would allow the seamless entry of mobile virtual mobile operators.

4.2 International experience

Almost all public policy proposals, at one point during their development, go through the analysis of international experience. Several relevant examples were found, but none could show the benefits and pitfalls of the model, as no network with similar characteristics had been built. Three cases were analyzed. Australia's FTTH project, one of the most ambitious infrastructure projects ever, was used to understand public involvement, competitive neutrality, and the concept of wholesale-only last-mile services. Kenya, with its "shared LTE network," was the closest that could be found to the incipient ideas. Finally, Rwanda, in a very similar fashion to Kenya, is in the process of implementing this model.

It is important to mention that, as a pure wireless wholesaler, Mexico's project does not have a parallel in the world. Lessons learned from international experience are being used to try to foresee likely hurdles in advance, so as to minimize their impact on the deployment of the network.

4.2.1 Australia

Australia is widely cited as an example of the State aggressively investing to connect to broadband infrastructure all households. The government announced in April 2009 (Australia, 2009) the creation of the National Broadband Network (NBN), stating that it would deliver superfast broadband at affordable prices. NBN would operate as a wholesale-only, open-access network provider. Ninety percent of all Australian homes, schools, and workplaces would be connected with speed up to 100 Mbps with optical fiber (fiber to the premises – FTTP), using next generation wireless and satellite technologies to people living in more remote parts of rural Australia.

The preliminary estimate at the time was that the NBN network would cost up to AU$43 billion. The government would seek private investment, but ownership restrictions would be established to protect the policy objective of developing a wholesale open-access network. The government's investment would be funded through the Building Australia Fund and the issuance of Aussie Infrastructure Bonds (AIBs).

The project began promptly, the organization was established with six offices in the country, and significant regulatory and legal work was completed. As the rollout of the FTTP network began, the project started being delayed. An independent assessment (NBN, 2013) commissioned by the company found that, among other factors, there was "an unrealistic assessment by key internal and external stakeholders of the complexity and time required to complete the task." By September 2013, the rollout was 48% behind and expenditure 26% below the corporate plan, though it was ahead of the spending that would have been required to reach the levels of actual rollout achieved.

The plan was modified, changing to an optimized multi-technology approach that would achieve better economics, while at the same time bringing high-speed broadband to as many people as possible. The current plan now considers taking FTTP to 20-26% of premises (instead of 90%), FFTN/FTTdp/FTTB[15] to 44-50%, and HFC[16] to an additional 30%. The premises served by fixed wireless (on 2.4 and 3.5 GHz bands) and satellite would remain about 10%, as originally planned. The financial plan was adjusted accordingly.

Although not developed specifically for this venture, Australia has well-defined competitive neutrality policies. These policies, aimed at promoting efficient competition between public and private businesses by not allowing government businesses to enjoy competitive advantages over their private sector competitors because of their public sector ownership, directly apply to NBN. There should be no resource allocations distortions arising out such ownership.

4.2.2 Kenya

Kenya started reviewing the provision of Wireless broadband in 2010. In November of that year, the government first made public the idea that LTE infrastructure could be constructed by a PPP and then sold on a wholesale basis to new and existing providers. The objective was two-fold: make better use of limited spectrum and foster competition to bring LTE to rural areas. The plan contemplated the use of 190 MHz in the 2.5 GHz band, licenses to an independent company, to build an open access

[15] Fiber to the node, fiber to the distribution point, fiber to the building
[16] Hybrid fiber coaxial

wholesale network from which operators could purchase capacity. The envisioned result was to have a single, highly utilized network with low unit costs.

At the time, the Kenyan government was skeptical about assigning spectrum to individual operators, as, according to official sources, there were 19 potential buyers but only three could be accommodated; also, an auction would translate into high prices for spectrum, which would then translate into high prices to consumers. The idea was highly criticized at the time, especially because of the "one-size-fits-all" strategy that such network would entail for all broadband retail providers.

The government would provide spectrum as equity and the network would be built through a collaboration scheme between operators and suppliers. The rationale behind was that buying capacity instead of acquiring spectrum would be more cost effective for operators. Initial rules asked for commercial services to be offered by 2012 in all 47 counties in Kenya and bidders had to be at least 20% Kenyan-owned. The government wanted to involve various operators, vendors, and broadband providers, including Telkom Kenya, Airtel Kenya, Essar Telecom Kenya, Safaricom, Alcatel-Lucent, Nokia Siemens Networks, Kenya Data Networks and Epesi Technologies. The government failed to say which spectrum band would be used.

As early as 2011, Safaricom, the market leader, had started LTE trials. By 2012, it was threatening to discontinue its involvement in the construction of the wholesaler if the government insisted that the deployment were to be done using the 2.5 GHz frequency band. According to the company, the limited range of this band would make the implementation of the LTE network prohibitively expensive; it wanted to secure the use of the 700 MHz, which at the time was currently held by TV providers. As early as 2011, it was clear that Saraficom's exit from the joint venture could derail the government's proposal.

In March 2013 elections were held and the new government, which took over in April 2013, did not fully embrace the wholesale project. The project is not mentioned in the Communications Commission of Kenya 2013-2018 (CCK, 2013) nor in the National Broadband Plan (Kenya, 2013). In November 2013, Safaricom announced that it was pulling out of the joint national 4G network and started demanding the licensing of frequencies. The wholesale network suffered a setback and is now a project on hold. The government is rethinking its spectrum strategy, setting a new task force (January 2014) that will study the possibility of spectrum sharing among operators. This has been taken as a tacit admission by the government that the nationwide 4G wholesale network under a PPP agreement had been shelved (ITU, 2014).

4.2.3 Rwanda

Rwanda is the only country in the world that is implementing a spectrum-sharing model similar to Mexico's. On March 11, 2013, the Rwandan government, through the Rwanda Development Board (RDB), and South Korea's KT Corp (KT) announced a joint venture to deploy an LTE network in the country. The venture is intended to develop, construct, operate, and provide wholesale infrastructure services to mobile service providers and MVNOs. Under the intended public-private partnership, the government will extend investment incentives while KT will be responsible for the deployment of the network and the operation of the company including transfer of technical and commercial know-how. The deployment of the new infrastructure will add to the fiber optic infrastructure already deployed by the Government of Rwanda together with KT, after KT and the government signed a USD 40 million deal to install and operate 2,300 km of fiber-optic backbone. KT Corp is now in talks to narrow key differences such as the division of shares in the firm.

The high level regulation that would apply to the network was set forth in the National Broadband Policy for Rwanda (Rwanda, 2013). The provider shall manage the broadband infrastructure, providing wholesale services to private service providers licensed by the ICT authority, offering guaranteed performance and adequate service level agreements that are transparent, neutral, fair, and non-discriminatory.

The main objective is cover with LTE infrastructure 95% of the population by 2017. The contract is structured as BOT (build-operate-transfer) PPP, with a 25-yer contract and spectrum concession.The deployment started in October 2013 with an estimated investment of more than $140 million joint venture firm is Olleh Rwanda Networks Ltd. The Rwandan government's 25 year-term equity investment will be in the form of access to its national fiber-optic networks and the spectrum needed to deploy the network.

4.3 The Mexican model

The constitutional amendment requires, in one of transitory articles, that the Executive Power, in coordination with the IFT, will guarantee the deployment of an open shared telecommunications network with the following characteristics:

- Deployment should start before the end of 2014 and should be fully operational by 2018.
- It will use:
  - "At least" 90 MHz of the digital dividend (700 MHz band);
  - Assets from the state-owned national electric utility' fiber optic cables;
  - Any other state-owned asset.
- Financing can be private, public or both. In case the State requires to fund the network, it should be approved by Congress.
- No service provider can "have influence" over the operation of the network;
- It should comply with coverage and quality obligations and should provide services on a non-discriminatory fashion at competitive prices;
- It should be operated under the principle of infrastructure sharing of all of its elements in an unbundled fashion;
- It can only provide wholesale services, either to resellers or to other network operators;
- Any network operator that buys wholesale services from this network is obliged to provide such network services to other players applying the same conditions they receive from the wholesaler;
- Its rates should promote competition and guarantee that profits are used to modernize the network, expand and comply with universal coverage obligations.

In a nutshell, what the constitution mandates is the deployment of a wholesale network, using the 700 MHz band, that will allow wireless broadband services to become universal. It will rely on third parties to reach the end consumer. Current players, we well as new asset-light players, can buy capacity and resell it. In case incumbent networks buy services from the wholesaler, they are obliged to unbundle their network and provide to other similar conditions.

4.4 The economics behind the Mexican model

The Mexican model was based on a comparative study of different alternatives to be able to reach with a wireless broadband network, at the lowest cost possible, 98% of the population. The two basic scenarios considered were (a) the status quo, which meant auctioning the spectrum to private players

and letting market forces play, and (b) leverage the 700 MHz spectrum to create a national wholesale wireless network.

The team built a bottom-up demand model that considered current and expected future use, demand elasticity parameters for entry (cost of handset) and on-going service prices, a replacement model (upgrade of handsets). For each of the demand scenarios, supply models were built to estimate the infrastructure and its cost to meet expected demand, for a greenfield and brownfield (that is, leveraging existing assets) deployment. The supply-demand models were related, as service costs determined likely retail prices, which in turn determined demand and the required network build-out.

Cofetel also analyzed the likely costs associated with incumbent players deploying the LTE on top of their current networks and with the possibility of refarming their own spectrum. The study performed outside-in evaluations with the best available public information.

In order to understand the cost of universal service, the supply-demand model was first capped at 85% of coverage, which is comparable to existing supply for mobile services. Then the marginal investment and cost to reach 98%, which would be the ultimate goal, was estimated. This was used to gauge access supply, a necessary but not sufficient condition to improve take-up of broadband.

The second condition centered on improving affordability, without entering into the arena of direct or indirect subsidies. Firstly the working team concentrated in understanding unit and marginal costs. These, in the end, determine market behavior and the viability of players. Then a competitive intensity assessment was performed, in order to evaluate the likelihood that cost savings are realized and that they are passed on to consumers through low end-user prices.

Of all the analyses performed, several findings are worth pointing out:

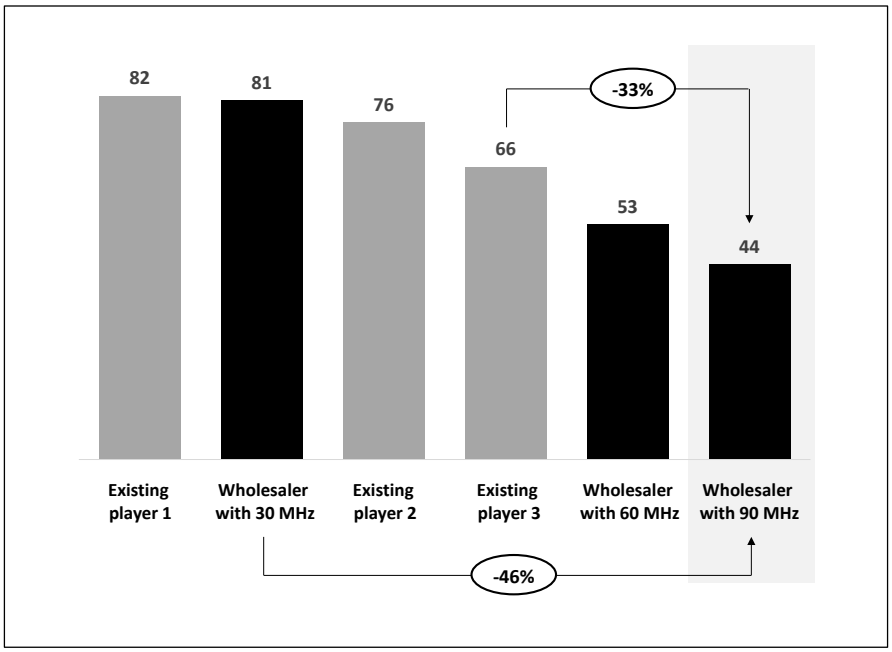
- Coverage for 85% of the population requires around 3,450 sites. An additional 4,700 sites would be required to reach "universal" coverage (98% of pops).
- The investment required to achieve the lower level of coverage would be around USD 1.97 billion. An additional USD 4 billion would be required for the ultimate goal.
- That would result, given expected demand, that the cost per GB would be 4 times higher for the marginal (rural) 13% of the population.
- As with more spectrum fewer sites are required, a wholesaler with more spectrum on the 700 MHz band results in a more competitive cost structure. The cost per GB in 2023[17] would be 81, 53 and 44 US cents if the wholesaler were licensed 30, 60 and 90 MHz, respectively.
- Universal service coverage would entail much higher costs[18]. The working group estimated that in 2023 the cost per GB would be USD 1.10 if it could capture at least 50% of the traffic.

On a best-effort basis, assuming each of the existing players were to receive 30 MHz of spectrum in the 700 MHz band, so that they could complement their network and make the best use of their passive infrastructure as well as refarming their current spectrum holdings to their benefit, the largest player would be able to achieve a cost of 66 US cents per GB. That cost is 50% higher than the cost that a wholesaler, using the full 90 MHz, of the digital dividend, would be able to achieve.

[17] The exercise assumed a 10 year period for a full roll-out.

[18] This was defined as "rural coverage," increasing the network's footprint from 85% to 98%.

Figure 3.
Estimated cost structure in the Mexican wireless market
US cents per GB in 2023



Source: Author's analysis based on Cofetel (2013)

It is noteworthy that a wholesaler with only 30 MHz (at 81 US cents) would not be cost competitive. It would have little or no impact in the market and would probably be an inefficient use of available spectrum. On the other hand, with the full 90 MHz, the wholesaler would be able to lower unit costs in the market by 10 to 20% through aggressive pricing and still be positive on a net present value basis.

Assuming a reasonable regulatory scenario and that there is adequate regulatory oversight of the wholesaler's pricing so that cost benefits are passed through and that it provides timely non-discriminatory access, the new entity would bring about two structural changes in the market.

On the one hand, incumbent players would be able to complement their network at a much lower cost than if they build it themselves. This is especially relevant to the two players with the highest costs, who would be able to compete with a better cost structure against the largest player. As it is, the economics of these two players, all else being equal, will always be structurally disadvantageous. This situation arises partly because of scale, but most importantly, because of their spectrum holdings, as only one player owns a national license on the 850 MHz (the original B band). The other two players split the A band geographically, thus they can only achieve a lower cost structure in certain areas. This structural issue can only be salvaged were these two players to merge. Unless there is more competition in the marketplace or they were to subject themselves to price regulation, this is an unlikely scenario, as it would be hard to get regulatory approval given that the market would become a duopoly.

On the other hand, by significantly reducing barriers to entry for new players by providing access to a low cost network platform, the wholesaler should enable more competition at the retail level. More players in the market would likely make retail prices decline faster. The estimates of additional decline in prices, according to the study, ranges from 12% to 16% beyond the status quo scenario.

One aspect that has not been considered in the previous analysis and that can have a large impact on the end game is the cost of the spectrum. The above costs for incumbent players do not include any up-front payments and on-going royalties for the right to use the spectrum. Up-front licensing would make unit costs higher, but this would be on an accounting basis only. Nevertheless, Mexico also levies annual payments, thus impacting the cash cost structure. This point will be addressed in more detail in the next section.

As there is no evidence that universal coverage would be achieved under a private market auction scenario unless stringent coverage requirements are put in place in future licensing[19], the rural market, which is much more costly to serve, was considered separately. Instead of comparing incumbents' versus wholesaler cost structure, the decision, independently of cost was of no coverage versus expensive coverage. It is clear that the wholesaler would not affect the economics of a rural build-out. It could, though, optimize costs, as a single at-scale network would be more efficient than multiple networks with overlapping footprints just capturing a fraction of the demand. Rural access is challenging in many respects; it needs to be a decision based not only on economics, cost-benefit trade-offs and creation of public welfare, but also on the State's obligation of providing access, as was determined in last year's constitutional amendment. In Mexico's case, at least, it was decided that rural build-out would be carried out.

The model has been widely criticized by parties with vested interests. The most common argument is that it is not possible that the government can be more efficient than the private sector; the government believes that structuring a PPP should eliminate this problem. Other critiques have centered in stating that significant innovation comes from facilities-based competition; one network will stifle innovation, which will only be seen at the services level. Though it might be true, little strong evidence has been provided so far; the government thinks that the benefits brought about by a lower cost structure and more competition are more important than innovation in only one part of the network.

4.5 Open issues

As can be seen from the description of the basic economics of the network and the mandate from Congress, several issues were not tackled or studied in detail, so they were left open. In the end, Cofetel only gave Congress enough instruments with which to take a high-level decision: build a wholesale network using the entire digital dividend. Significant work lies ahead.

Except for very general rules (non-discrimination, open access, unbundling of all the technically feasible elements), no guidelines for the framework to regulate the wholesaler were defined. Furthermore, any conceivable structure can be used for the ownership and financing of the network, as investment can be "private, public or both." All three issues, fundamental in nature, were left for the implementation team to decide.

4.5.1. On the regulatory framework

Mexico is in the middle of the process of writing the legislation to implement the constitutional amendment. It is likely that the new telecommunications and broadcasting law will center in general competition rules, asymmetry in cases of dominance, and detailed interconnection regulation. It will

[19] This approach has become widespread in Latin America. Colombia, Chile, and Brazil impose rollout obligations. Mexico has never used this lever for wireless players, though it imposed these kinds of requirements to Telmex during its privatization process in 1990.

lower barriers to entry for infrastructure-based players and resellers and will try to create an environment that promotes convergence of networks and services. It will not concentrate on detailing rules for the wholesale market, except for those cases related to significant market power and interconnection. Thus, the law will allow the regulator and the Executive Power to detail the secondary legislation pertinent to a wholesaler.

Many of the discussions around the wholesaler have centered on minimizing potential negative distortions. To that effect, and based on international best practices, the law will mandate certain competitive neutrality elements. Firstly, no network with public ownership would be allowed to provide services to end consumers. They will probably be defined as pure wholesalers. It has also been discussed that such networks will have coverage requirements, as well as quality and price regulation.

As of today, it has been decided that detailed rules would be included in the licensing agreement. In terms of coverage and quality, any obligations should be easy to define, as long as they are based on sound economics and are feasible without eliminating the cost-structure advantage.

Nevertheless, in terms of price regulation, little progress has been made. A typical rate-of-return regulation scheme seems to clash with the overall objective of promoting an efficient use of the spectrum and creating a system that passes on to consumers as much of the economic surplus created as possible. A price cap system with productivity clauses seems to be a better approach, but it creates the complexity of forecasting technological advances that could potentially have a significant impact on unit costs. As it will be explained later, this increases the difficulty of attracting private investment for the deployment of the network.

4.5.2. On the ownership structure

The latest estimates of capital expenditures required for this network amount to close to USD 10 billion, executed over five years. The detailed planning and costing exercise is work in progress. Given past experiences in public works, in Mexico and worldwide (e.g., Autralia's NBN), it is likely that any estimate will be conservative in nature and that cost over-runs will be unavoidable. It is extremely unlikely that Mexico has the ability to fund this amount, either through direct investment or the placement of debt. For comparison purposes, it is worth mentioning that Mexico budgeted in 2014 USD 3.1 billion for its flagship conditional cash transfer program (Oportunidades). Telefónica Movistar, Mexico's second mobile player, invested in 2013 only around USD 310 million.

Though it has not been fully decided, total public ownership seems extremely unlikely. Private investment is required and will be attracted through a private-public partnership (PPP). Mexico is in the process of retaining investment bankers that will structure and market the partnership. Three aspects still have to be overcome: (1) What will Mexico's equity contribution to the PPP be?; (2) Is there an exit strategy? (3); How will the PPP partner be chosen?

Contribution to the PPP: It seems obvious that Mexico will be contributing with the 700 MHz band, as well as other assets (some fiber optic, certain rights of way, and the possibility of using state-owned premises). The spectrum will be assigned directly, but the remaining question is how to determine a value to it. Neither the government nor its advisors have performed a valuation, as coverage and quality obligations have not been set yet. International benchmarks will be of limited value, as the 700 MHz band has just recently been put up for auction internationally and many countries are opting for processes with significant beauty-contest characteristics.

To comply with competitive neutrality conditions, the spectrum will probably be subject to on-going yearly payments. On the one hand, existing operators have been adamant about this issue, as they insist that this is fundamental if the wholesaler is to compete fairly. On the other side of the table, proponents of the network argue that the wholesaler's cost advantage will be available to all players in the market, so no unfair advantage is given by exempting the spectrum from such payments.

This issue is a deal breaker. Through a non-transparent process, the Ministry of the Treasury, in its 2014 budget, included a clause that taxed the band with royalties of close to USD 700 million per year. Though it later retracted and excluded the clause, not before it reached Congress and became a openly debated issue, it was clear that such payments would have made the wholesaler economically non viable.

Exit strategy: To align long-term incentives and avoid political meddling, it is desirable that the State is a partner in the venture during the riskiest part of the implementation and then exits the joint venture. This would return the State to its regulatory and supervisory role, without any conflicting interests. No decision has been taken yet, but the team seems to be inclined to propose a clear exit path.

PPP partner: The private partner will most likely be chosen through an open auction process. An international roadshow will be conducted in the near future, looking for consortia that have enough depth, in terms of experience and financing resources, to commit to this long term investment. The constitutional amendment clearly states that incumbent operators cannot participate, so the government will have to be able to attract either national equity from non-telco investors, or it will have to attract foreign capital. The working team is already mapping out potential interested investors.

The pricing mechanism, though, has not been decided yet. Using price of services as the main auction parameter, as most investment bankers and competition experts have proposed, does not seem appropriate. It is the opinion of the author that such assignment mechanism will result one of two undesirable scenarios.

On one end, capped prices set through an auction process could make the venture economically non-viable. If this were the case, once it is fully operational, it cannot be sent to a regular bankruptcy process, as it provides a public service; it would need to be rescued by the government, costing taxpayers significant amounts of money, minimizing investment and rendering the network technologically obsolete. In essence, it would end up costing the economy not only in terms of funding, but also in unrealized economic spillover.

On the other end, prices could be so lax as to create significant economic rents for the partner and for the government. Almost by definition this is an undesirable outcome. Renegotiating the contract to lower prices, although possible, is not desirable as it increases risk perception, not only in telecommunications but in any other sector that requires similar contracts (e.g., energy). As a counterargument, it has been stated that revision clauses could be included in the contract. Nevertheless, these types of clauses are undesirable as they create legal uncertainty. Furthermore, they take long to implement and would always be subject to lawsuits, injunctions, and judicial intervention. For most of its recent history, Mexico's telecommunications regulators have had trouble enforcing these types of clauses. It should not risk placing itself in this position in the foreseeable future regarding the wholesale network.

Conclusion

As Mexico is in the process of implementing the first-ever wireless broadband wholesale network, it has been addressing several issues simultaneously given the tight timeframe. From a high-level perspective, all relevant decisions have already been made, but now the country faces the drafting of legal operational details. As the wholesaler was mandated by a constitutional amendment, it is extremely unlikely that the country will revise this strategic decision. The network will be up and running in a timely manner. Hopefully, it will achieve the expected goal: universal coverage at the lowest cost possible through competition in retail services.

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