The Linked World: Working Paper Series

Impact of ICT on Production of Goods and Services: Policy and Development of ICT—The Impact of Public and Regulatory Policy on ICT Sector Performance

By
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About The Linked World Project

Information and communication technology (ICT) has decisively established itself as a general purpose technology—one that affects an entire economy. Over the past four decades, ICT has spurred dramatic changes that will continue for the foreseeable future. Harder to predict, though, is the exact nature of those changes, and how they will play out across societies—in our economies, our cultural relationships and the way human beings interact.

This notion formed the basic motivation for embarking on the study, which the Telefónica Foundation agreed to underwrite in 2008. The purpose of *The Linked World: How ICT Is Transforming Societies, Cultures, and Economies* is to take stock of our knowledge on what the economic, social, and cultural impacts of ICT will be. How has it evolved, how much have we been able to quantify or to evaluate in a qualitative sense, and what does it mean for the challenges and opportunities ahead?

The Linked World: How ICT Is Transforming Societies, Cultures, and Economies is the result of a two-year global research project led by The Conference Board and underwritten by the Telefónica Foundation.

This working paper is one of a global series that forms the basis of the book *The Linked World: How ICT Is Transforming Societies, Cultures, and Economies* published by the Telefónica Foundation and Artel Press.

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Policy and Development of ICT—The Impact of Public and Regulatory Policy on ICT Sector Performance

by

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1. INTRODUCTION:

The purpose of this chapter is to discuss the influence that policy and regulatory variables can exert on the performance of the ICT sector. It starts by raising the fundamental question as to whether public policy has an impact on the development of the sector. In doing so, we not only focus on the telecommunications sector, but also the other elements of the ICT eco-system, including computing, software and IT services. It then moves to identify the policies and frameworks that are consistently associated with above par sector performance. The objective is to determine what policies are more likely to influence successful ICT sector development in mature and emerging markets. For example, do markets with more open, stable and predictable regulatory environments yield more robust ICT sectors? Similarly, what non-regulatory policy initiatives successfully promote dissemination of ICT, and how does their success depend on the policy and regulatory framework?

From there, the analysis moves to determine why some countries are more effective than others in implementing policy tools. Are there any specific variables acting as influencers, enablers and/or obstacles of potential policy and regulatory frameworks? What institutional arrangements and policy frameworks are better suited to maximize ICT sector performance?

The methodology relied upon to tackle these questions combines statistical analysis and case studies. The statistical analysis focuses first on measuring the aggregate impact of public policy on sector performance. To complement the aggregate analysis, two sets of econometric analyses on specific policy impacts were conducted. First, we studied the policy variables that are more or less conducive to stimulate the investment in Next Generation Networks (e.g. fiber optics in the local loop). Second, we specified a model aimed at identifying the policy variables driving innovation in telecommunications services. In this last case, the dependent variable was consumer adoption of mobile broadband services.

To complement the statistical analysis, in-depth case studies covering the policy impact on the development of all areas of the ICT sector (telecommunications, software applications and services) were developed for seven countries selected on the basis of their performance in sector development: China, Korea, Japan, Brazil, Mexico, Sweden, and Estonia. The objective of the case studies was to identify the institutional and cultural variables that are less conducive to being operationalized through a statistical analysis, but which exercise a critical impact on the development of the ICT sector. The importance of government planning, a sector vision and a blueprint guiding that plan, as well as the role assumed by the leadership, ownership and accountability of the executive branch of government, were some of the variables we studied.

The combination of the statistical analyses and case studies led to the following conclusions:

1. Government policy plays a critical role in enhancing performance of the ICT sector. The statistical analysis relating the performance of the ICT sector to a standard set of policies for a sample of 52 countries indicates that public policy and sector performance are intricately

linked. The performance of the ICT sector measured in terms of ICT adoption, quality, product innovation, and consumer benefit in terms of lower prices is statistically linked to the adoption of pro-competitive policies, guaranteed by regulatory independence and guided by an overarching vision for the ICT sector. Furthermore, when controlling for economic development, if a country adopts policies of managed competition, guaranteed by an autonomous regulator, and generates a target vision for the ICT sector, the result will be a vibrant sector benefiting the country and its population. These statistical analysis findings have been validated through case studies of sector performance for Korea, Japan, Brazil and Estonia. China is a particular case in which sector development occurred through the implementation of a centralized planning framework lacking any sort of regulatory independence. In that sense, the Chinese case, while validating the importance of the policy variable, represents a peculiar path to achieving high sector performance.

2. Among the policies studied, the development of appropriate competition models for the telecommunications sector is a critical driver of sector performance. Healthy competition is required not only to yield price reduction in services but also to stimulate innovation and investment. The analysis also indicated that sustainable competition models result in industry structures exhibiting a moderate amount of consolidation of the telecommunications sector, which tends, in turn, to stimulate innovation by creating greater certainty of returns. As such, the statistical analysis indicated that platform-based competition in broadband is positively linked with higher likelihood of investment in fiber optics in the local loop. Similarly, the enactment of mobile number portability, by reducing customer switching costs, increases the likelihood of product innovation, which results in more intense launch of mobile data applications.

The statistical analysis findings were also confirmed by case studies. Despite the existence of service-based competitive regimes, platform-based competition was shown to be the primary driver of broadband development in Japan, Korea, Sweden. However, sustainable competition embodies the presence of two or three vertically-integrated players with sufficient capacity of innovation and investment. Limited competition resulting from a highly-concentrated industry structure, acts as an obstacle for the development of broadband, as the Mexican case study indicates.

3. However, telecommunications policies need to be integrated within an overall vision and blueprint of the target ICT sector, including all other elements of the eco-system (software applications, content development and computing). The case studies of China, Korea, Estonia and Japan indicate that telecommunications policy is generally inserted within a comprehensive framework linking the telecom sector to IT services. This overarching framework should be captured in a vision and blueprint of what the goal of sector development is. The countries studied conceive infrastructure development (e.g. telecommunications) as inextricably linked to content and applications.

The development of a vision and blueprint helps in achieving clarity and certainty in the definition of a regulatory framework and policy set. Estonia is a country where vision, blueprint

and regulatory certainty are interrelated. On the negative side, the lack of vision and policy uncertainty in Mexico has had a negative impact on the development of the ICT sector.

4. Infrastructure oriented policies need to be combined with an emphasis on demand-side policies to stimulate ICT adoption. As the case studies indicated, an important portion of the digitally-excluded population is caused not by lack of reach but due to socio-economic and cultural limitations. The case studies of Sweden, Estonia and Korea (all three with high rates of technology adoption) set the paradigm in terms of implementing demand-side policies focused on enhancing digital literacy, subsidizing access to the disenfranchised and developing applications that promote adoption.

5. In addition to specific policies, proactive and continuous government planning is a key lever to drive performance improvement. The statistical analysis concluded that most countries achieving superior performance of the ICT sector exhibit an adherence to the development of high-level, combined with detailed sector, multi-year planning. Top ICT sector performance is statistically linked to this practice. This finding was confirmed by a number of case studies (Sweden, Korea, Japan and Estonia).

However, some case studies indicated that planning alone is not sufficient to improve sector performance. The case studies of Korea and China indicated that the likelihood of planning success increases with management practices, including disciplined follow-up and appropriate channels of communication between the public and private sectors.

6. Policies and government planning need to be complemented with leadership and ownership from the executive branch. While identified in countries with widely divergent political culture, the case studies of Korea, China, Sweden and Brazil pointed to the importance of assigning the development and monitoring responsibility of the digital agenda to the highest levels of the executive branch. This results in the ability to steer all branches of government and the administration in a coherent direction and enhances the possibility of enforcing the fulfillment of the vision.

These six conclusions represent the core findings of this chapter. In the following sections each of them will be expanded in order to present the data supporting them, as well as providing specific implications. Before addressing the study findings, reference will be made to the wealth of research literature generated to date that was used to create a theoretical framework that served as context to the analysis.

2. THEORETICAL FRAMEWORK FOR ASSESSING POLICY IMPACT ON ICT SECTOR PERFORMANCE:

The policy variables that affect ICT sector performance have multiple dimensions, ranging from the regulatory to the institutional, both being either specific or not to the sector. For purposes

of our quantitative analysis, we have grouped these policies in three clusters[1]: 1) the institutional framework, 2) the regulatory framework, and 3) non-sector specific policies which can have a spillover effect on the ICT sector.

The institutional framework variables comprise the factors such as the type of governmental entities that are in charge of developing ICT policy or regulating the sector and the providers of service. For example, the variables included in this cluster comprise the overall ICT policy environment (e.g. existence of Cabinet-level position centralizing all ICT policy matters (telecommunications, content, computing), the scope and scale of a telecommunications national regulatory authority, its enforcement powers and independence, the existence of an overarching ICT national planning process, and the scope of government participation in the ICT sector.

The regulatory framework cluster comprises all the variables related to specific ICT policies and regulatory approaches. They include market entry regulation (e.g. vertical separation, local loop unbundling, rights of way, numbering scheme, spectrum management), price regulation (interconnection, mobile termination rates, weighted average cost of capital, retail pricing), investment incentive regulation (e.g. asymmetry), the regulatory process (e.g. market analysis ex-ante), and the application of regulation (e.g. technological neutrality, operational conditions, compliance monitoring).

Finally, non-sector specific policies that can have an impact on the performance of the ICT sector comprise variables such as direct foreign investment restrictions affecting market entry and capital structure, other trade restrictions affecting services supply, proactive long-term government planning, and regulation of audiovisual content affecting convergence (e.g. restrictions of telecommunications carriers regarding content distribution). In particular, policies that promote and facilitate the adoption of ICT by late adopters (socio-economic disenfranchised and small and medium enterprises), such as digital literacy programs and equipment subsidization, play an extremely important role in fostering the emergence of a high-performance sector.

The ways each of these three clusters evolves over time allow the formalization of four stages of development of ICT policy. These stages have been defined not only according to the level of competition but also whether in the later policy development stage the government is defining a strategic plan for growing the ICT sector and maximizing its socio-economic impact (see figure 1).

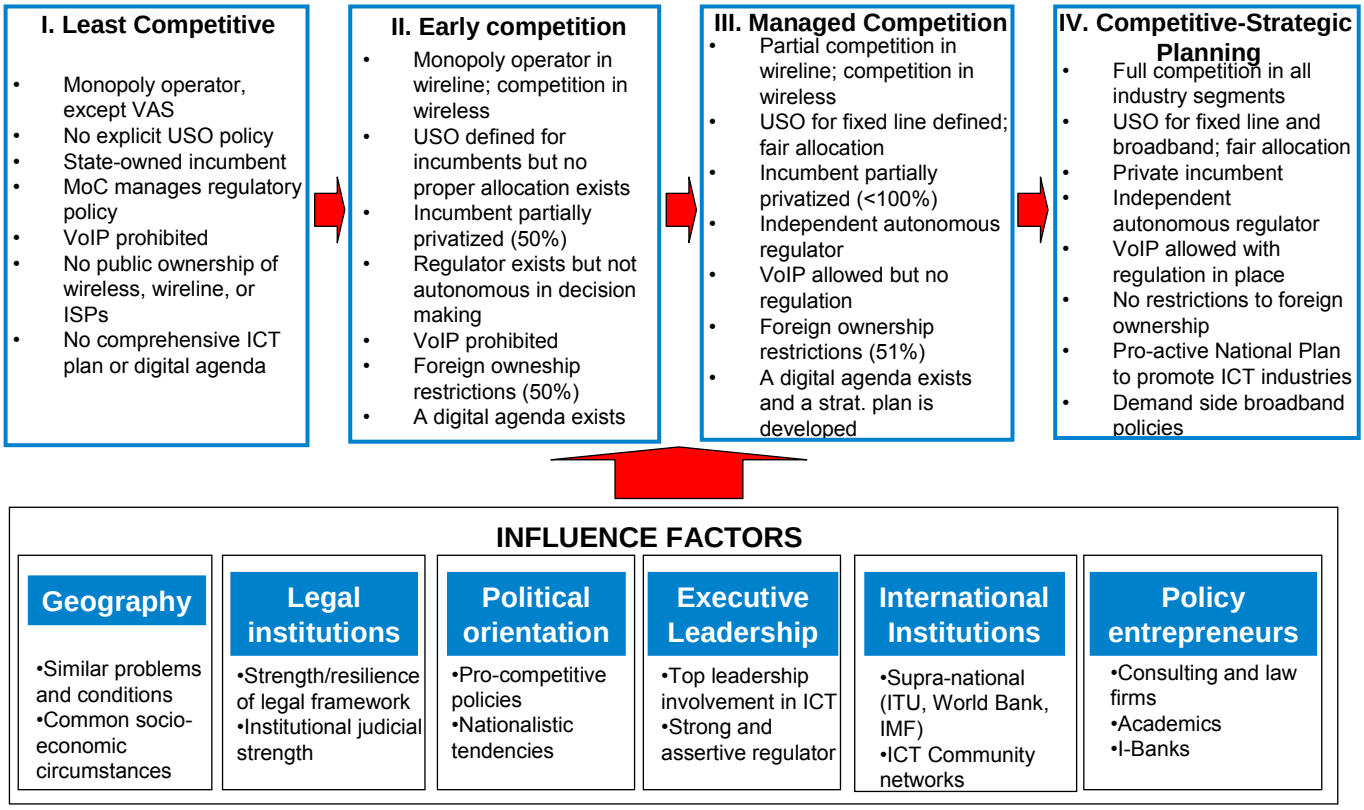
Figure 1. Stages of ICT Policy development Impact

[1] Detailed descriptions of each cluster have been included in the review of the research literature included in appendix.

Cluster	Policies	Stage I Least competitive	Stage II Early competition	Stage III Managed Competition	Stage IV Competitive / Strategic Plan
Institutional Framework	Regulatory independence	MoC manages regulatory policy	Regulatory agency exists within MoC but is not autonomous in decision making	An independent regulator exists and is autonomous in decision making	An independent regulator exists and is autonomous in decision making
	Privatization stages	State owned	Partially private (50%)	Partially private (<100%)	Fully private
	Industrial and/or development plan	No agenda or digital plan exist	A digital agenda continuously updated exists	A digital agenda exists; a strategic plan is under development	Pro-active National Plan to promote ICT industries exists
Regulatory Framework	Level of competition	Monopoly operator, except VAS	Monopoly in wireline; competition in wireless	Partial competition in wireline; competition in wireless	Full competition in all segments
	Universal Service Obligations	No explicit USO policy	USO defined for incumbents but no proper allocation mechanisms exist	USO defined for wireline, fair allocation mechanisms exist	USO covering fixed line and broadband; fair allocation mechanisms exist
	VoIP regulation	VoIP prohibited	VoIP prohibited	VoIP allowed but no regulation in place	VoIP allowed, with regulation in place
Non-sector specific variables	Wireless,VAS, ISP ownership restrictions	No competition; no public ownership	Ownership restrictions apply to foreign investors (50%)	Ownership restrictions apply to foreign investors (51%)	No restrictions to foreign ownership
	Fixed line ownership restrictions	No competition; no public ownership	Ownership restrictions apply to foreign investors (50%)	Ownership restrictions apply to foreign investors (51%)	No restrictions to foreign ownership
	Demand-side policies	Not existing	Implementation of telephony Universal Service Fund	Deployment of public access facilities for broadband	Promotion of ICT adoption and applications usage by SM&E; Universal broadband policies

It is understood that countries move from one stage to the next driven by a set of either tangible or intangible idiosyncratic factors (see Hoffman et al., 2009): legal system, political culture, level of economic development, linkage to a network of international policy influences (e.g. Commonwealth countries) (Katz, 2009). By including those factors, a comprehensive conceptual framework of ICT policy development can be drawn (see figure 2).

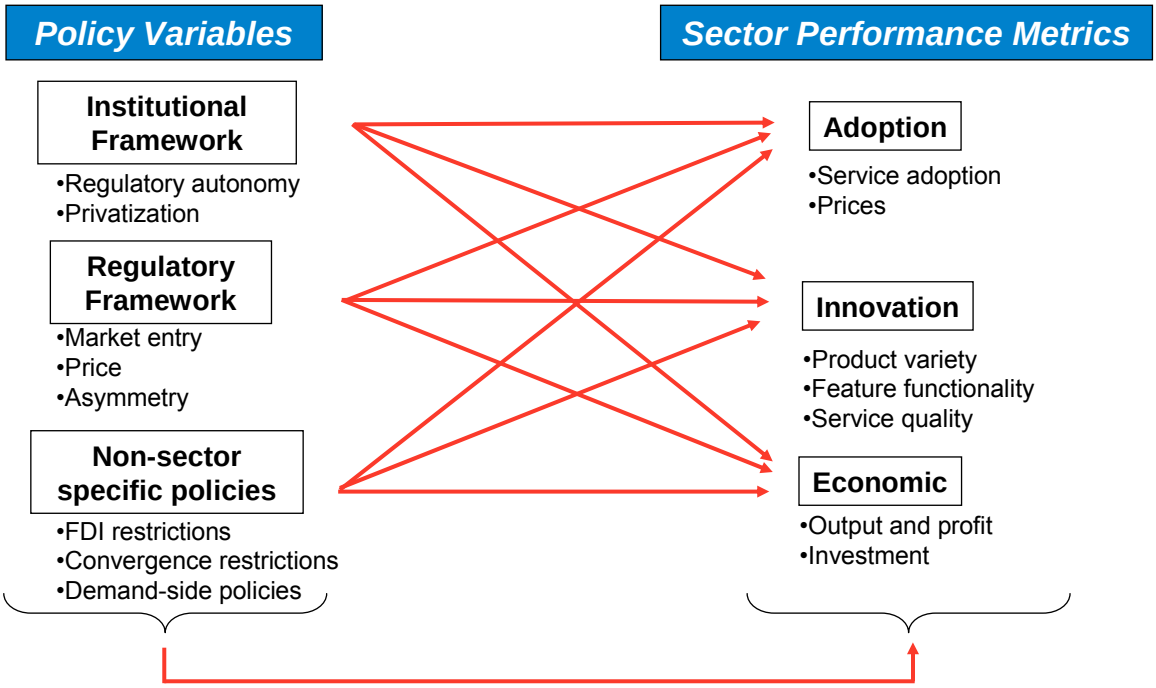
Figure 2. Conceptual framework of ICT policy stages



As the conceptual framework indicates, the adoption of ICT policies is influenced by a number of tangible and intangible factors. The geographic influence appears to be relevant in terms of either location proximity or countries sharing common socio-economic circumstances which results in adoption of policies addressing similar problems and conditions. Similarly, the role of institutions and policy entrepreneurs acting as networks of influence is important in leading countries to move from one stage to another. Finally, the political environment, both in terms of economic policy orientation and executive leadership, has a significant influence on the direction and speed of change.

The three clusters of policy variables can have an impact on ICT sector performance, which can be measured along three types of dependent variables: 1) technology adoption, 2) product innovation, and 3) economic performance (see figure 3).

Figure 3. Causal links between policy and sector performance



Technology adoption variables measure not only penetration (e.g. computer adoption, broadband subscribers per population or households, wireless subscribers per population), but also pricing trends that can stimulate adoption via demand elasticity (e.g. broadband subscription, wireless service revenue per minute, etc.). Innovation variables focus on product variety, feature functionality and service quality. They can be measured through indicators such as percent of mobile ARPU (average revenue per user) derived from data services, quality of service (in mobile services, dropped calls, service coverage; in wireline services, mean time to repair, number of faults per total access lines), etc. Finally, economic performance variables comprise industry output and profits (revenues and EBITDA margins), and capital investment.

Previous Research

The research literature reviewed for this study has provided evidence regarding the impact of the institutional framework on service adoption and sector economic performance. For example, telecommunications regulatory autonomy benefits consumers by leading to wireless price reduction and, consequently, enhancing service adoption. Likewise, privatization of state-owned monopolies has a positive statistically significant effect on sector performance (Bouras et al., 2009) and improved institutional framework (e.g. independent regulatory authority, lower corruption, and contract enforcement) leads to better performance (Maiorano et al., 2007; Waverman et al, 2007)

Second, the regulatory framework, particularly specific policies, has significant impact on telecommunications service adoption and sector economic performance. For example, competition in wireline has a positive statistically significant impact on network deployment (Li

et al, 2004; Grzybowski, 2008; Wallsten, 2001). In the case of wireless, the policy framework affects the diffusion and pricing of wireless services. For example, competition and number portability (when combined with regulatory autonomy) have a positive impact on wireless prices and penetration, while number portability has a negative impact on prices (Maiorano et al. (2007); Grzybowski (2005)).

In the case of broadband, access regulation discourages investment by incumbents and individual entrants even as entrants' total investment increases. With very few caveats, platform-based competition appears to be the key variable explaining broadband deployment, as concluded by Distaso et al. (2006), Cava-Ferreruela et al. (2006), Boyle (2008), Wallsten (2006) and Garcia-Murillo (2005) (although in this case for high-income countries). Lee et al. (2008) determine that the impact of platform-based competition is stronger when the share of technologies reaches parity (this related to competitive intensity). Waverman et al. (2007) determined that unbundling tends to weaken facilities-based competition and reduce infrastructure investment. Conversely, most studies provide limited evidence on the importance of local loop unbundling in fostering broadband adoption. There is a small, statistically insignificant positive effect (Distaso, et al., 2006; Cava-Ferruela et al., 2006), and a small effect which is neither consistently positive nor consistently significant (Wallsten, 2006). Bauer et al. (2004) was the only study that failed to identify an impact of competition policy on broadband penetration, although this could be related to the early time at which the research was conducted and its reliance on very preliminary data sets, while Ford and Spiwak (2004) determined that unbundling prices had a positive impact on broadband availability.

Beyond these findings, the impact of policy on level of innovation as well as the comprehensive impact of all policy variables on sector performance has not yet been fully analyzed. More specifically, research on the assessment of the impact of policy variables on rate of sector innovation is nonexistent. Similarly, there is limited analysis on the impact of trade regulation on sector performance. Finally, no comprehensive study between all regulatory and policy variables and full sector performance has been identified. This has led us to focus our quantitative analysis in the areas that require additional insight in terms of the relationship between policy and sector performance:

- What is the relationship between policy and sector performance?
- What is the aggregate impact of comprehensive policy and regulatory initiatives on sector performance of sustainable competition models on the ICT sector?

3. THE RELATIONSHIP BETWEEN POLICY AND ICT SECTOR PERFORMANCE

What level of influence does public policy have on the performance of the ICT sector? To respond to this question, a cross-sectional statistical analysis of 52 countries was conducted to establish the causality existing between the policies in place and the development of the ICT sector. For this purpose, two indices were developed to rank countries on sector performance and policy regime.

Sector Performance Measures

To measure telecommunications sector performance, four "levels" were defined (see figure 4).

Figure 4. Telecommunications Sector Performance Levels

	Level 1 Rudimentary	Level 2 Emerging	Level 3 Advanced	Level 4 World Class
Service penetration				
● Fixed telephony lines	0-19%	17-32.9%	33-50%	>50%
● Wireless subscribers	0-25.9%	26-49.9%	50-75%	>75%
● Fixed broadband lines	0-9.99%	10-19.9%	19.9-30%	>30%
Data services				
● Mobile Broadband Penetration	0-17.9%	18-35.9%	36-54%	>54%
● FTTH penetration	0-2.99%	3-5.9%	6-9%	>9%
Wireless data as a percent of ARPU	0-14.4%	14.5-22.5%	22.6-30%	>30%
Pricing (as portion of GDP per capita)				
● Variable Costs of mobile services	>0.83%	0.83-0.57%	0.56-0.29%	< 0.28 %
● Monthly Costs of mobile service	>0.11%	0.11-0.08%	0.07-0.05%	< 0.04 %
● Annual Costs of fixed line services	>8.98%	8.98-6.00%	5.99-3.00%	< 2.99 %
Price of Broadband (Mbit/U.S.$ PPP)	$ >24.66	$ 24.66-16.73	$ 16.72-8.80	$ <8.79
Service quality				
● Fixed line faults per 100 lines	>72%	72-48%	47-24%	<23%
● Percentage of telephone faults cleared by next working day	0-28.9%	29-52.9%	53-75.9%	76-100%
Productivity				
● Number of Lines per Full time telco staff	0-305 0-1402	306-503 1403-2612	504-701 2613-3823	>702 >3824
● Subscribers per Wireless telco staff				
● Fixed line minutes (Local + LD)/ number of access lines (Annual)	0-3292	3293-6542	6543-9791	>9792

With this framework, the performance level for each indicator and the performance composite index for each nation were calculated for the year 2008. If the value for an indicator of a country is within a certain class range, the number for the corresponding level was applied[2]. Once the values were assigned to each indicator, the performance index was calculated as an average of all indicators. The implicit assumption of equal weights across indicators was made to avoid any subjectivity in the formulation of the index[3].

[2] For example, the fixed line penetration for the United States is 51.8%, meaning that fixed line density is 51.8 per 100 populations; since 51.8% falls within Class IV, the value assigned to the United States in this indicator is 4.

[3] Note: if information on an indicator is missing for a given country, it was excluded from the calculation of the composite index

As of 2008, only three countries in the world (Sweden, Korea and Japan) had reached "level 4 - World Class". A world-class country typically exhibits high adoption of all ICT services, high service quality and productivity. However, its differentiating features are high penetration of mobile data services, high deployment of fiber optics for broadband access and, consequently, faster download speeds for Internet access.

Twenty-one countries are ranked as "Level 3 - Advanced", including all industrialized countries (United Kingdom, United States, Denmark, Switzerland, Austria, Italy, Germany, Portugal, France, Finland, Spain, Iceland, Estonia, Slovenia, Czech Republic, Greece, Hungary, Slovak Republic, Belgium, Australia and Luxembourg). They exhibited high adoption of wireless and broadband services and while they have a profile similar to the "world class" countries, they lag with regards to the introduction of new services, such as wireless broadband and Next Generation Networks.

The "Level 2 - Emerging" countries comprise nations whose wireline penetration is relatively low, although they have reached this performance level due to leapfrogging the early developmental stages of voice telephony through wireless. Broadband adoption, however, remains moderate. Level 2 is comprised of two tiers. On the one hand, the "developing" countries are relatively more backward with regards to ICT, while the "transitioning" countries are actively moving across the sector performance scale. The 25 "developing" countries comprise nations in Africa (Kenya, Cameroon) and Emerging Asia (Mongolia, Pakistan) while the 21 "transitioning" countries are generally situated in Latin America (Brazil, China, Mexico, Uruguay, Argentina) and Eastern Europe (Poland).

Finally, "Level 1 - Rudimentary" countries, numbering 17, are generally located in Africa (Central African Republic, Ethiopia, Togo, Benin, Mali, Rwanda, Ivory Coast) and Asia (Kyrgistan, Nepal). In these countries, adoption levels of wireless and fixed broadband are very low, while pricing of telecommunications services still represents a large proportion of disposable income.

Turning now to the policy index, each country was assigned a score based on a set of policy options. These criteria allowed us to create a four-level policy index which ranks countries not only according the level of competition but also whether in the later policy development stage, the government has defined a strategy for growing the ICT sector and maximize its socio-economic impact[4].

As of 2008, 12 countries had reached a level 4 (Competition-High level Planning), while 20 are at stages 1 or 2 (see figure 5).

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[4] Each country was ranked based on the qualitative information provided by the ITU Regulatory database, as well as information collected by the authors for the availability/development of an ICT Development Plan.

Figure 5. Country distribution according to policy index (2008)

Policy Index	Stage I - Least Competitive	Stage II - Early Competition	Stage III - Managed Competition	Stage IV - Competitive / Strategic Planning
Country distribution (total=52)	1	19	21	12
Examples	Honduras	Costa Rica, Zimbabwe, Thailand, Paraguay, Cameroon, United Arab Emirates, South Africa, China, Uruguay, Bolivia, Mexico, Russia, Israel, Venezuela, Ecuador, Guatemala, Australia, Canada, Egypt	Turkey, Argentina, Slovenia, Bangladesh, Colombia, El Salvador, Estonia, Norway, Iceland, New Zealand, Belgium, Portugal, Singapore, Brazil, France, Slovak Republic, Austria, Germany, Switzerland, Peru and Denmark	Sweden, Japan, Netherlands, Italy, Chile, Finland, Ireland, Dominican Rep., Korea (Rep.), Spain, United States and the United Kingdom
Comments	● State-owned wireline monopoly ● Prohibition of VOIP ● Lack of transparency	● No clear definition of USO ● Early privatization stages	● The State still has a minority participation in the wireline incumbent ● Few countries keep some ownership restrictions for operators that managed spectrum and wireline operators	● The incumbent is fully privatized ● All industry sectors are liberalized ● There is regulatory independence and transparency ● There is a sector level government strategic plan

Note on intuitive country misclassifications: Australia and Canada maintain strict restrictions on foreign investment in telecommunications; The Israeli government has only recently sold a remaining participation in the wireline carrier, market structure is fairly consolidated, and there is no regulatory authority; in France, the government still holds more than 13% shares of the telecommunications carrier and only recently started developing a national

plan; Denmark has only partial competition in mobile. On the other side, Spain and Dominican Republic are considered in Stage IV given their aggressive liberalization agendas and national broadband plans.

The distribution indicates that only one out of 52 countries is in Stage I, confirming the assessment that the wave of sector liberalization has largely swept the whole world. At the same time, most countries are located within Stages II and III; few attain Stage IV in terms of liberalized sector combined with a comprehensive ICT National Sector Strategic Plan.

Statistical Relationship between Policy and Performance

Having defined the ICT sector performance and policy indices, the existence of causality between both indicators was investigated —whether a higher level of policy performance led to higher sector performance. A regression for 2008 indices, which controlled for the level of economic development, yielded the following results:

Source	SS	df	MS
Model	13.364543	2	6.682272
Residual	4.4388356	49	0.905885
Total	17.803379	51	0.349086

Number of obs	=	52
F(2,49)	=	73.77
Prob > F	=	0.0000
R-squared	=	0.7507
Adj R-squared	=	0.7405
Root MSE	=	0.30098

Performance_Index	Coef.	Std. Err.	t	P > | t |	[95% Conf.	Interval]
Regulatory_Index	0.2560787	0.1009838	2.54	0.014	0.531442	0.4590133
GDP_PPP_Capita	0.0002770	3.41E-06	8.14	0.000	0.000021	0.0003460
_cons	1.1657720	0.2766412	4.21	0.000	0.609840	1.7217030

According to the linear regression, at a significance level of 5%, the positive relationship between the sector performance and the policy indices cannot be rejected.

Historical evolution of policy and performance

The alignment between the policy and performance variables did not provide any indication as to whether all countries in the world follow similar developmental paths whereby both indicators are related in a linear way. The case studies were helpful in testing whether a single developmental path exists or countries might reach higher stages of ICT sector development by following idiosyncratic paths. To understand these paths, the historical evolution of the ICT sector performance and policy indices for selected countries were plotted over time (see figure 6).

Figure 6. Policy Stages and ICT Performance Levels (1980-2008)

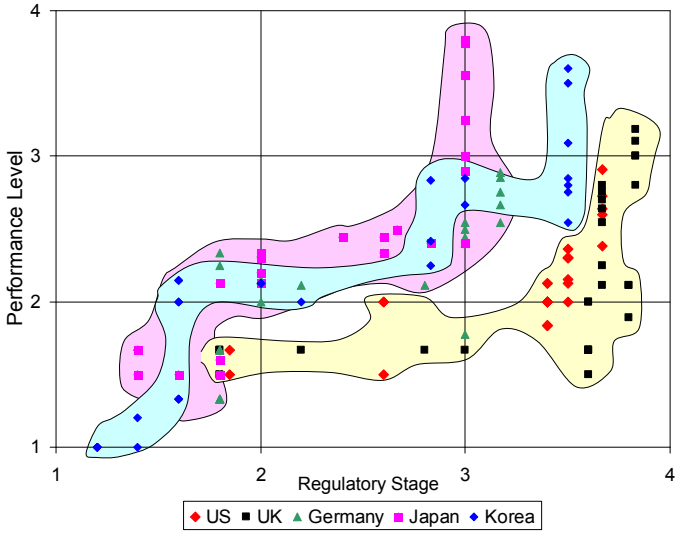

Figure 6 indicates that policy paths followed by different countries over the past three decades differ widely. There appear to be three different paths by which countries transition from low to high ICT performance:

- **The Anglo-Saxon path:** the U.S. and the U.K. had to extensively liberalize their telecom sector before improvements in sector performance materialized. The U.S. and the U.K. pursued an early market opening, beginning in 1984 and culminating in the 1990s with almost full liberalization. However, rapid liberalization did not immediately translate into leaps in sector performance for either country. This may have to do with other factors correlated with performance, e.g. the slow economic growth during that period. It may also indicate that the regulatory framework was in some ways ahead of its time. Technology that would have allowed new entrants to develop physical or virtual alternative networks was not readily available at the time. Consumers, having been used to monopolistic prices and moderate service levels for so long, were initially slow to take advantage of the new choices offered by competitive players. Entrepreneurs and financiers needed some time to spot and evaluate the new opportunities that liberalization offered.

- **The gradual liberalization path:** by contrast, Germany and Japan followed a path of late liberalization and privatization. Both remained essentially Level 1 countries in terms of their policy index until the mid-1990s. For both, the incumbent monopoly provider of telecommunications services was largely protected from competition in core services and in turn was required to maintain high investments and appropriate staffing levels to provide the country with advanced infrastructure and services. This policy worked remarkably well over many years when technological change and customer expectations were relatively moderate, and both countries showed rapid improvement in performance levels until about the early 90s. At this point, Japan overtook the U.S. to achieve the highest performance level among leading industrialized nations. In the mid-1990s, however, Japan and Germany entered a

phase of rapid liberalization. Regulatory focus in both countries shifted from protection of the incumbent to creation of a broad base of competitive players. While the examples of Japan and Germany show that countries can reach high levels of sector performance without complete deregulation -notably through high capital investments in network infrastructure - it appears that the only feasible path to Level 4 performance is rapid liberalization combined with sector level planning

- **The developing path:** Korea, a country that initially had fewer resources than the other industrialized nations, had to gradually liberalize the telecom sector, in order to achieve step-by-step an improvement in performance. The Korean path represents an alternative path to the other two models in the sense that a move on the policy index is followed by a step-wise improvement in performance.

To sum up, while the two variables -policy and performance- are intricately linked, there appear to be alternative development paths to achieving high levels of sector performance. Governments can follow early, rapid or late/restrained liberalization and both philosophies can lead to good performance. There are, however, two important sets of preconditions for this transformation: in a regulated environment, the incumbent needs to be reasonably efficient and the taxpayer and/or user should be prepared to shoulder significant capital outlays. In a liberalized environment, efficient capital and labor markets must exist that allocate resources to the most promising ventures. Alternatively, the government should provide some high-level guidance with regards to the industry developmental path.

4. THE DEVELOPMENT OF A SUSTAINABLE COMPETITION MODEL:

As indicated in the section above, the development of a competitive environment is a key policy in driving high sector performance. In fact, the statistical analysis indicated that countries with the highest level of ICT sector performance exhibit a common set of policy features:

- Full competition in all telecommunications industry segments
- Universal Service Obligations for fixed line and broadband, driven by a fair allocation of contribution across industry players
- Privatized telecommunications incumbent
- Voice over IP telephony allowed with a regulation in place
- No restrictions to foreign ownership of industry players
- Pro-active national plan to promote ICT industries within a comprehensive eco-system (software, services, applications)

Countries that have achieved this stage include Sweden, Japan, Netherlands, Italy, Chile, Finland, Ireland, Korea, Spain, United States and the United Kingdom

However, not all telecommunications competition models are equally powerful in stimulating investment and innovation. As indicated above, sustainable models, which comprise a

moderate return to scale and platform-based competition, appear to be the most efficient approaches. This conclusion was tested both through statistical analysis and case studies.

4.1. Platform-based competition and broadband development:

There is a consensus within the industry that, given the current trends in adoption and usage of bandwidth intensive applications, ultra-broadband platforms, capable of handling download speeds beyond 50 Mbps, need to be deployed. Many developed nations are witnessing the roll-out of either fiber to the home (for telecommunications carriers) or DOCSIS 3.0 (for cable TV players) to achieve these performance levels. Is the policy variable an important factor in explaining which countries are at the forefront of this trend? We hypothesize that this is the case and that platform-based competition policies appear to be the right model to promote investment in fiber to the home. To test this hypothesis, a model was specified[5] in which fiber optics in the local loop was a function of pricing as a measure of competitive intensity, local loop unbundling as a regulatory obligation, and a set of control of variables, such as GDP per capita and population density:

$$FTTH_{it} = g\,(P_{it}, LLU_{it}, GDP_{it}, DEN_{it})$$

Where:

F: represents FTTH as a percentage of total broadband accesses
P: advertised average retail price per Mb
LLU: dummy variable depicting whether local loop unbundling has been enacted as a policy to facilitate entry of new broadband operators by obliging the incumbent to open up its network and offer access at regulated price
GDP: GDP per capita
DEN: population density

We hypothesized that:

(i) the lower the retail price, the more competitive intensity, and therefore, the less incentive to invest in new access technologies, in particular fiber, since the rate of return of capital would be lower as ARPU (average revenue per user) would decrease;

[5] The model was specified for an unbalanced panel of 32 countries between 2005 and 2008, which allowed estimating it using pooled data. The main data source was the OECD broadband portal, supplying information of Fiber to the Home (FTTH) connections as a percentage of the total broadband connections since 2006; it was complemented with IDATE data. The source of Local Loop Unbundling data was the OECD and the ITU regulatory database available for the years 2005 to 2009. The source of GDP information was the IMF (2005-2008) while the source for population density was the OECD and WDI.

(ii) a regulatory obligation to provide access of the network at a regulated price represents a disincentive for the incumbent to invest in new access technologies since it would require the incumbent to share its newly-acquired advantage with the new entrants, thereby reducing its capacity to differentiate product; and

(iii) carriers will invest in markets with higher demand profile and higher population density as a way to positively affect the rate of return because of size of primary demand and potential economies of scale

Model results indicate that fiber deployment is negatively related to local loop unbundling regulations and the level of competitive intensity (see figure 7).

Figure 7. Panel Data Estimation - Fixed Effects

Source	SS	df	MS		Number of obs =	88
					F(4, 83) =	9.23
Model	188.413476	4	47.103369		Prob > F =	0.0000
Residual	423.599406	83	5.1036073		R-squared =	0.3079
					Adj R-squared =	0.2745
Total	612.012882	87	7.03463083		Root MSE =	2.2591

ftth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
llu	-1.468644	.6708716	-2.19	0.031	-2.802981	-.1343077
gdp	-3.49e-06	.0000205	-0.17	0.865	-.0000442	.0000373
densidad	.0087334	.0020984	4.16	0.000	.0045597	.0129071
price	-.037539	.0152102	-2.47	0.016	-.0677914	-.0072865
_cons	1.823524	1.034692	1.76	0.082	-.2344377	3.881485

According to the model results, unbundling local loops is negatively related, at a significant level, to the penetration of fiber to the home. Consistent with the research literature previously reviewed, platform-based competition acts as a stimulus of investment in forward-looking technologies. Furthermore, as expected, population density is positively linked to fiber deployment. Higher density raises the rate of return of capital investment because it allows a larger number of customers to be connected to the newly deployed network. Finally, the pricing of broadband services is negatively related to fiber deployment. If pricing is an indicator of competitive intensity, the lower retail prices of broadband, the less incentive there is to deploy FTTH because, at lower average revenue per user, the net present value of the fiber project diminishes[6].

This finding has been validated through case studies in Korea, Japan, and Sweden: while the three countries have loop unbundling regimes, it was only when competition between

[6] This finding runs counter the conclusions of the study by the Berkman Center for Internet and Society, *Next Generation Connectivity: A Review of Broadband Internet Transitions and Policy from Around the World* (October, 2009), and is consistent with the comments issued by Robert w. Crandall, Everett M. Ehrlich and Jeffrey A. Eisenach, *Declaration Regarding the Berkman Center Study* (NBP public notice 13), November 16, 2009

infrastructure players developed that the incentive for deploying broadband and fiber in the loop increased.

For example, broadband initially developed in Korea not through unbundling of access (service-based competition) but rather through platform-based competition. Broadband service was introduced in Korea in 1998 when Thrunet, a cable TV operator, launched service. Subsequently, other operators (Dreamline, SKT y Onse) entered the market by leasing infrastructure from other cable TV operators. In 1999, Hanaro, an alternative carrier competing with Korea Telecom in local telephony services, entered the broadband market through ADSL and cable modem platforms. This led the incumbent to respond by replacing its original ISDN platform with ADSL. In 2002, after platform competition had developed and at the same time that the privatization of Korea Telecom was concluded, the government introduced legislation aimed at unbundling the local loop to lower the costs of new entrants. This led to the entry of numerous competitors, triggering hyper-competition, which resulted in price wars and product commoditization. These competitive dynamics led three of the top four market share leaders to face financial and operating shortfalls. Thrunet and Onse filed for bankruptcy in 2003, while Hanaro was actively searching for alternative investment sources. At this time, the government intervened actively in the process leading to consolidation of players in a small number of vertically-integrated operators.

In Japan, following the original distinction between Type I and Type II carriers, regulators defined rules for a service-based competition model which could have served as a framework to develop broadband. Along those lines, in 2000, new competition policies comprising collocation and unbundling rules were implemented to open up bottleneck facilities to other competitive carriers. Based on this decision, competitive providers to NTT, the incumbent, were able to gain access at low cost to copper lines to the customer premise and metropolitan fiber connections between the incumbent's central offices. The net result of this policy was the growth of the unbundling industry and the drop of NTT's share of the retail ADSL market to 38% by March 2007. Nevertheless, the impact of unbundling on broadband deployment was primarily limited to ADSL service over copper lines.

In 2001 the Japanese telecommunications market entered into a major consolidation phase[7], leading to horizontal integration via convergence of transmission platforms around IP-based networks, combined with vertical integration across the four layers of the competition model. This process of consolidation led to the emergence of strong vertically-integrated providers, which triggered platform-based competition around fiber infrastructure. K-Opti.com (a subsidiary of the Kansai Electric Power Company), STNet (a subsidiary of the Shikoku Electric Power Company) and many large cable TV operators started deploying and operating fiber-

[7] Among the transactions, this process comprised acquisitions by the KDDI group (Yozan, Powered.com, 3 Tu-ka companies, and the Tokyo Electric Power Company's FTTH business) and by Softbank (Vodafone and Japan Telecom, as well as Cable & Wireless IDC group).

based facilities in direct competition with NTT. As a result, facilities-based competition in fiber-enabled broadband is currently prevalent in all large metropolitan areas[8].

In Sweden, platform-based competition has been driving innovation and investments in broadband. Initially, an open access model on copper network (ULL) combined with competition with cable TV had a positive impact in stimulating broadband penetration. This resulted in dynamic efficiencies from more broadband applications and services, which led, in turn, to continuous increases in broadband capacity. In this context, fiber to the home became the natural next step, whereby continuous investment remains critical for platform-based competition scenario. Beyond municipalities and alternative carriers, the incumbent fiber deployment was triggered by competitive activity. Until recently, TeliaSonera, the incumbent, had not tackled any major fiber roll-out, with the exception of scattered collaborative municipal projects. The carrier originally introduced ADSL2+ capable of delivering up to 24Mbps. Increasing demand for even higher speeds, especially for HDTV, and Telenor/municipalities fiber investment drove TeliaSonera to begin deploying the new platform.

In sum, both the statistical analysis and the case studies provide support that platform-based competition remains the most powerful incentive to stimulate deployment of advanced broadband infrastructure.

4.2. Moderate consolidation and product innovation:

In another case, an attempt was made to identify the characteristics of an industry structure and competition model that maximize product innovation stimuli. Along these lines, we posit that, while competition is a necessary pre-condition to lead carriers to search for advantage through product differentiation, there appears to be a level of competitive intensity beyond which the incentives to invest and deploy advanced products diminishes. To test this hypothesis, a model was built to explain the rate of adoption of mobile Internet. Mobile Internet was chosen because it represents the next frontier of product innovation in the ICT sector, comprising several supporting platforms from wireless broadband (3G, HSPA, LTE) to innovative devices (Blackberry, iPhones), to the range of applications stores offered by providers like Apple, Nokia, and Microsoft.

According to this model, the rate of adoption of mobile Internet (measured by the percent of mobile industry revenues derived from these services) is a function of market structure (in other words, the degree of market consolidation and competitive intensity), a range of regulatory policies (from institutional variables such as the degree of regulatory independence

[8] This is facilitated by exogenous factors such as population density and the fact that aerial deployment of fiber on the last mile is permitted in Japan, which substantially reduces the cost of the overbuilt infrastructure.

to regulations such as number portability) and a set of control of variables, such as GDP per capita, size of target market and level of urbanization[9]:

$$REVDATA_{it} = g\,(M_{it}, P_{it}, S_{it})$$

Where:

REVDATA: represents the percentage of revenues derived from mobile broadband for a given country

M includes a market structure variable:

- HH: Herfindahl-Hirschman Index for the mobile industry in a given country

P comprises four policy and regulatory variables:

- IDMC: indicator of regulatory independence in a given country
- MNP: dummy variable indicating the existence of mobile number portability
- NMPY: years since mobile number portability has been enacted
- OWNCAP: indicator of foreign ownership restrictions in wireless service providers

S comprises four socio-demographic variables:

- GDP: GDP per capita (measured in U.S.$ PPP)
- EF: index of economic freedom
- URBAN: urbanization index
- POP: percentage population between 15 and 64 years of age

Accordingly, the following hypotheses were formulated:

(i) In competitive markets, consolidation increases incentives for innovation. According to the research literature in industries other than telecommunications[10], high levels of competition could promote a greater focus on measures aimed at yielding operating efficiencies and reducing costs. On the other hand, lower levels of competition as a result of strategic alliances or consolidations could reduce the risk of innovation initiatives.

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[9] The model was specified for a panel of 42 countries between 2002 and 2008. The source of the dependent variable (percent of revenues derived from mobile data), used as a proxy of level of innovation in a given market, is the Merrill Lynch Mobile Matrix. The Herfindahl-Hirschman Index was calculated from market share contained in the same data base. The main source for the regulatory data was the ITU regulatory database. Regarding the control variables, the source of GDP per capita is the IMF, the Index of Economic Freedom is derived from the annual report provided by the Heritage Foundation, and the urban population index and the population between 15 and 64 have been gathered from the WDI databases.

[10] Nicholls-Nixon & Woo, 2003; Rothaermel & Deeds, 2004; Shan, Walker, & Kogut, 1994

(ii) Certain sector and non-sector specific policies and regulations represent an incentive to innovate
   - Policies oriented toward reducing customer switching costs (e.g. number portability) will stimulate innovation in order to preserve loyalty;
   - A regulator perceived as insufficiently independent from the government will reduce the incentive to innovate because a successful differentiation strategy could lead to asymmetric pressures (e.g. renegotiate licenses, artificially set price caps);
   - Sector restrictions to FDI (trade, corruption control, etc.) could result in limited willingness to innovate

(iii) the policy variables notwithstanding, companies will invest in markets with higher demand profile; this is, therefore, a control variable

To test the first hypothesis a piecewise specification is introduced for the Herfindahl-Hirschman Index. LHHI1 indicates markets where the HHI is under 0.3600 and LHHI2 indicates markets where the concentration level is equal or greater than 0.3600. By relying on logarithmic functions in order to render this model linear, the following model was specified:

$$LREVDATA_{it} = \beta_0 + \beta_1 LHHI1_{it} + \beta_2 LHHI2_{it} + \beta_3 LMNP_{it} + \beta_4 NMPY_{it} + \beta_5 LGDP_{it} + \beta_6 LEFI_{it} + \beta_7 LURBAN_{it} + \beta_8 LPOP_{it} + \beta_9 IDMC_{it}$$

Figure 8. Panel Data Estimation - Fixed Effects

Revdatait	Coef	Std.Err	P>|t|	
LHHI1it	0.4957	0.2999	0.0990	*
LHHI2it	1.4812	0.4821	0.0020	***
MNPit	0.1216	0.0675	0.0730	*
NMPYit	0.0575	0.0170	0.0010	**
LGDPit	1.4016	0.3206	0.0000	***
LEDIit	-0.4188	0.6240	0.5030	
LUrbanit	3.3711	1.4740	0.0230	**
LPOPit	7.1762	3.6486	0.0500	*
IDMCit	0.0510	0.0407	0.2130	
Cons	-58.8322	14.5801	0.0000	***

Sample	282	
Periods	7	
Observations	43	
R^2	0.6274	
F-test	23.2	(0.0000)
Heterocedasti	110000	(0.0000)
Wald X^2 (43)		

* 10% significance level
** 5% significance level
*** 1% significance level

The model results led to several conclusions:

- Market concentration is directly linked to innovation**:** consolidation provides operators with a higher certainty of potential returns to invest in wireless data development[11].
- Mobile number portability and years of policy enactment is directly linked to innovation: portability does not necessary lead to churn but the threat of churn provides, as was hypothesized, an incentive for operators to innovate in products in order to build loyalty

[11] To test the existence of an inverted-U relationship between innovation and market concentration, a model with a quadratic HHI term was also estimated (e.g. B_1 HHI + B2 HHI^2). According to the theory, B_1 should be positive, while B_2 negative to prove the existence of a quadratic relationship and that the optimum point of the quadratic shape is a maximum. The results obtained showed that the signs of the coefficients behave accordingly to the theory but were not significant. This situation could result from the lack of information on product innovation in countries with HHI greater than 0.6.

- Regulatory independence and innovation are not significantly linked: in the mobile market, the market is driving innovation and the degree of regulatory independence is not an important variable in explaining new product development
- All socio-demographic variables are directly and significantly linked to innovation: market potential is a critical variable driving innovation

To conclude, beyond the expected market attractiveness, innovation in wireless Internet appears to be driven by two factors from the public policy toolbox. First, a moderate amount of competition is required to stimulate innovation. Policy initiatives aimed at fragmenting the structure of supply beyond an optimal level will have a negative impact on the degree to which operators will innovate in products and services. Aggressive spectrum allocation aimed at multiplying the number of players, small spectrum caps preventing market concentration and MVNO licensing might have a negative impact on innovation insofar that higher-than-optimal competition acts as a deterrent from product differentiation.

Second, the threat of growing churn embodied in number portability, which lowers customer switching costs, acts as an incentive to innovate in order to enhance loyalty. Third, in a market that has been significantly liberalized around the world, regulatory independence appears to play no role in fostering innovation. The optimal level for deployment of wireless broadband is driven by a certain amount of market concentration and a moderate level of competitive intensity. The higher market concentration is, the larger the incentive to innovate. This could be associated with both the certainty of obtaining a return to the introduction of a new product (wireless data products) and the ability to capture a larger share of demand.

The Mexican experience confirms these findings from a negative standpoint. A very gradual market liberalization and hesitancy in opening markets has significant negative effects in sector performance. The privatization of Telmex had benefits in terms of accelerating the deployment of fixed line telephony, in particular reaching high penetration at lower levels of the socio-demographic pyramid. However, the incumbent was capable of establishing a significant number of barriers to entry in local telephony through either sector-specific (interconnection rates, license restrictions) or non-sector specific (limits to foreign ownership). These were reinforced by a legal system that guaranteed the capability of delaying any government attempts to liberalize the market. These barriers had a negative effect on wireline service deployment. The proof of the important positive contribution of competition toward sector performance lays both in the broadband and wireless sectors. The activity of cable TV operators in the former and wireless competitors in the latter resulted in a more dynamic market, leading to higher static and dynamic efficiencies[12].

[12] Recent regulatory moves taken by Mexican authorities confirm the will to move sector dynamics to becoming more competitive. The SCT launched an auction for three concession licenses to operate dark fiber belonging to the state electricity company. This auction is aimed at boosting competition against Telmex wireline business. In addition, the antitrust authority has concluded that Telmex has a dominant position in call termination on fixed lines, while AMX has a dominant position in the wireless market. It remains to see whether these moves will result in stimulating competition.

5. FROM A REGULATORY POLICY TO AN INDUSTRIAL POLICY:

Countries that have succeeded in building a high performance ICT sector have transitioned from developing policies on a sector-by-sector basis (telecommunications, software, science and technology, computing) to an integrated comprehensive mode. An integrated approach to ICT policy development recognizes the interconnected domains of ICT (infrastructure, demand, production, and adoption) and sectors (telecommunications, applications, and devices). An integrated approach translates initially in the formulation of a vision of the future of ICT for the country which is defined to guide the multi-year planning effort.

For example, in Korea, each of the multiple plans formulated in this country has been guided by an overarching visionary objective such as "reach world class ICT performance levels by 2010" (*1996-2000 First National Informatization Promotion Plan*), "build a knowledge-based society" (*Cyber Korea 21*), "development of broadband leadership" (*Broadband IT Korea Vision 2007*), and "broadband convergence and ubiquitous networks" (*u-Korea Master Plan*).

In Japan, the government developed in 2006 an overarching strategic policy labeled *u-Japan*, which was guided by three targets:

- Elimination of non-broadband served areas, establishing that by the end of 2010, broadband service should be available to 100 % of the population, while high speed broadband should be available to 90 % of the population.
- By the same year, 80% of the population should value ICT as a tool to address social needs
- Finally, in the same year, 80 % of the population would be ICT literate in order to feel at ease accessing the Internet and computer technologies

Interestingly enough, the goals in Japan's 2006 strategy comprises infrastructure, digital literacy and social objectives.

In Sweden, the government enacted in 2000 the "*Information Society for All*" bill, establishing that broadband should be considered a universally accessible utility. This bill led to the development of the *Broadband Support Program (2001-7)* which focused funding to deploy broadband in rural and isolated areas and building a national backbone. In 2007, the telecommunications regulator issued a broadband strategy with the objective of achieving universal service.

In Estonia, the first integrated effort to create an information society was defined in 1998, when the parliament adopted the *Principles of Estonian Information Policy.* This bill was further refined by the *Principles of Estonian Information Policy 2004-2006*, elaborated and approved in 2004 and the *Estonian Information Society Strategy 2013,* approved in 2006, where it was defined that, by 2013, 75% of Estonian residents will be using the Internet, while household Internet penetration will amount to 70%.

In addition to formulating an overarching vision, moving from a regulatory policy to a comprehensive industrial policy recognizes that the development of a telecom sector and the creation of export-oriented IT services and software industries have to be linked. In Korea, policy makers determined that meeting demand on the domestic front and leveraging the industrial power of big conglomerates could allow the country to build an export base in electronics, IT and communications. Initially, however, objectives were articulated around meeting internal demand for an upgraded telecommunications infrastructure and entering the electronics arena. According to this approach to ICT sector development, incubation of an export-oriented industry is linked to funding adoption of its products in the domestic market. A key policy objective of all Korean master plans has been the articulation of industrial policies such as R&D promotion, the development and diffusion of industry standards, training of ICT resources, the promotion of e-Government applications and the provision of seed capital for infrastructure deployment. The Development Fund benefits from private sector contributions through spectrum licensing fees, a percentage of revenues from operators and interest-earning loans. As such, one of the fund's primary objectives is to reinvest profits of the ICT sector in the sector itself. Over time, the guiding principle for the formulation of policies evolved toward "building the information society". Based on the overarching goal of developing an advanced information society, Korea formulated several successive master plans, which comprised both supply and demand-side policies. Finally, Korea's policies regarding broadband development were always focused on the development of an applications and services sector both benefiting and acting as a stimulus of infrastructure usage. As a result, the development of broadband acted as a stimulus for the creation of a content industry. Among the newly-created industries, Korea counts an $8.3 billion online gaming, a $ 3.4 billion domestic content industry, as a well as a home-grown Internet search sector.

With a similar objective of promoting the development of an equipment manufacturing industry, the Ministry of Information and Communication in Japan set up in 2007 the *ICT International Competitiveness Enhancement Program* aimed at promoting Japanese products and developing world markets through a collaboration of industry, academia and government. This program has been actively endorsed by the ICT manufacturing sector. In addition, the development of ICT strategies has been constantly supported by large domestic high technology companies, such as Canon, Mitsubishi, Nintendo, Panasonic, Sony and Toshiba.

In Estonia, in order to develop a domestic technology cluster, the government is sponsoring the Competence Centre in Electronics-, Info- and Communication Technologies (ELIKO) in 2004, formed by Tallinn University of Technology and private companies.

Finally, in China, by consolidating the Ministry of Electronic Industries (MEI) into the new Ministry of Information Industries (MII), Chinese policy makers aimed at cultivating state-owned champions in the telecom equipment space – ZTE and Huawei primarily – that now enjoy more than 60% market share versus foreign vendors.

6. THE IMPORTANCE OF GOVERNMENT PLANNING FOR THE ICT SECTOR:

Using the integrated vision as an overarching target development goal, proactive multi-year government planning is also a critical driver of sector performance. In Korea, the initial push for long-term ICT planning started in 1982, when the government designated telecommunications as a priority area. A key policy objective of all Korean master plans has been the articulation of industrial policies such as R&D promotion and the provision of seed capital for infrastructure deployment. The first national ICT focused plan was formulated in 1987 for an eight-year period. Starting in 1995, the government began preparing five-year plans with objectives ranging from broadband universalization to becoming a global IT leader. A significant feature of the Korean ICT government-sponsored planning process remains its holistic characteristic (Kim, 2010). Master plans are contextualized as tools for facilitating the transition into an advanced information society. This implied that planning dimensions included not only network infrastructure but also addressed services, applications and demand promotion policies. This last point represents a critical difference with the ICT sector development processes in other advanced economies. Planning efforts in other nations tend to have a heavy focus on network deployment and, while recognizing the positive spillovers that networks will have on other sectors, they leave promotional efforts in these related components of the ICT eco-system to market forces (a process that could be labeled as "build it and they will come"). Contrary to this philosophy, Korean policy makers tend, through their planning tools, to address all the components of the ICT eco-system in an inter-connected fashion, generating incentives in the areas of applications and services to follow through the build-up of networks.

Japan is a country with a sector-wide planning tradition similar to Korea. In parallel with the NTT privatization and sector liberalization process, the Japanese government developed ICT strategies aimed at developing a telecommunications and IT industry. The initial push for strategic planning in the ICT sector started in 2001, when the government developed the first e-Japan Strategy. The strategy planning process enabled the formulation of annual priority policy programs focused on implementation of objectives such as universalization of broadband.

In Sweden, the “Information Society for All” bill led to the development of the Broadband Support Program (2001-7) which focused funding to deploy broadband in rural and isolated areas and to build a national backbone. In 2007, the telecommunications regulator issued a broadband strategy with the objective of achieving universal service. In November 2009, the government released its Broadband Strategy.

In Estonia, the first integrated effort to create an information society was defined in 1998, when the parliament adopted the *Principles of Estonian Information Policy.* This bill was further refined by the *Principles of Estonian Information Policy 2004-2006*, elaborated and approved in 2004 and the *Estonian Information Society Strategy 2013,* approved in 2006, where it was defined that by 2013 75% of Estonian residents will be using the Internet, while household Internet penetration will amount to 70%.

The national planning efforts need to be complemented with detailed blueprints regarding their implementation. These roadmaps are quite helpful in generating the appropriate frameworks for introducing changes in the regulatory arena. In particular, the clear definition of a sector blueprint guiding sector development, privatization and liberalization appears to be critical. For example, the Brazilian experience is conclusive about the value of conducting a reform of the telecommunications sector in which privatization and liberalization are handled simultaneously, and both processes driven by a blueprint of market structure. While some features of the Brazilian process were not accounted for in the original intent--- sector consolidation and the construction of a "national champion"--- most of the design elements contained in the law have been achieved. Wireless telephony achieved nearuniversal levels, , prices have fallen dramatically and innovation dynamics worked well to fill the gap left by fixed broadband.

Similarly, the Estonian experience is a clear example of a successful quantum leap in ICT sector performance by combining infrastructure development through platform-based competition and demand gap programs. In addition, the deployment of initiatives in both areas was supported by the formulation of an overarching strategy aimed at building an information society.

The Mexican telecommunications liberalization experience proves the point of the importance of a blueprint guiding regulatory changes. While in theory local telephony service and wireless services in Mexico have been opened to competition since 1990 after the privatization of the incumbent, in practical terms the government allowed the privatized company to maintain a de facto monopoly by postponing the establishment of clear rules that would guarantee new entrants a fair environment to compete or delaying decisions when conceding licenses or auctioning frequency spectrum. This situation led to significant delays in the development of a vibrant ICT sector.

However, ICT national planning and blueprint development is only the beginning of a process that needs to be underpinned by good management practices. The case studies of countries that have excelled in this domain point to three practices: decoupling of planning from political changes, disciplined monitoring and follow-up of fulfillment of objectives on an annual basis, and ownership by the executive branch of government.

As mentioned in section 5 above, ICT planning is framed within a national vision of the target sector. This vision is the result of a consensus built among policy makers, the private sector, and civil society, and should be supported by major political parties. As an example, ICT planning in Korea is not a political tool subject to the vagaries of the political electoral cycle. It is the embodiment of state policies that capture a strategic vision, which in itself represents a consensus of all societal forces in the country. Similarly, in China, facilitated by the specificities of the country's political system, institutional centralization was reinforced with government sponsored planning. In Brazil, despite the changes in governments, a consistency in the development of sector objectives has prevailed and is expected to be maintained in the future.

A related best-management practice has to do with discipline in follow-up. In Korea, each plan is assessed in terms of its results at the end of the planning horizon and the results of the assessment are fed back in the formulation of the next iteration. In China, senior leadership performance reviews are tied tangibly to achieving detailed annual planning targets specifying network capacity expansion, coverage, and penetration – and quality standards.

Complementing multi-year planning and disciplined follow-up, leadership at the highest level of government in the promotion and oversight of ICT policy appears to be linked to high performance sectors. It is a common practice in Korea not only to name an "ICT Czar" but also guarantee this official access to the country's president on a regular basis. This places responsibility of steering the development of the sector squarely in the hands of the president. In Brazil, the National Broadband Plan is being developed by the Secretariat of Strategic Affairs of the President of the Republic and the *Casa Civil* and directly approved by the President.

In China, strong leadership from the top has been a key feature in China's ICT sector development. All senior management personnel decisions are controlled explicitly by the Communist Party in order to assure compliance with ministerial (Central/Party) directives. The telecommunications policy agenda has been formulated and driven primarily by ex-MIIT (previously the "MPT") Minister Wu Jichuan during his ministerial tenure from1993-1998. He was arguably one of China's most powerful civil government ministers ever. The MIIT reports to the State Council and is member of the State Information Leading Group (SILG). The SILG approves and modifies the regulatory framework and future directions for the telecommunications industry. In particular, the role of the SILG has been prominent in Internet regulation, focusing on controlling web content.

In some cases, governments extend their sector intervention beyond multi-year planning by actively shaping the industry structure. In Korea, at several points in the development of the sector, the government intervened in the market "in a focused and strategic way" shaping industry structure either with the purpose of creating national champions, fostering export-led industries, or addressing sector sustainability. The Korean government often negotiated with the giant conglomerates their participation in the telecommunications sector. For example, in the last tranche of privatization of Korea Telecom, the government agreed to permit SK Telecom to acquire 11.3% of shares, while LG acquired 2.3%. Similarly, the government fostered the consolidation of wireless players and broadband service providers at times of financial crisis.

The Brazilian government, recently concerned about the whole sector falling into the hands of foreign owners, engineered over the past two years the creation of a national champion by promoting the merger of two of the three major regional carriers: Brasil Telecom and Oi. This required the modification of the original *Telecommunications Law*.

The Japanese experience represents an example of a fine-tuned combination of top-down sector planning combined with the creation of a set of incentives to stimulate facilities-based

competition. While not explicit, the government has been constantly adapting the regulatory framework to the gradual consolidation of broadband and mobile sectors.
One should not underestimate the importance of policy implementation. As it is the case with business strategy, good policies need to be implemented appropriately in order to become effective. Good policy implementation practices comprise primarily two areas: active involvement of the private sector throughout the policy process, and constant monitoring of the unexpected impact policies might have.

While the policy domain is essentially a government prerogative, success in ICT sector performance is dependent on private sector participation (e.g. level of investment in infrastructure, new product development, etc.). Countries that have excelled at implementing ICT policies have the capability of creating formal and informal channels of communication with the private sector that allow players to provide feedback, generate recommendations, and suggest modifications. Korea and Sweden both have a process of consultation and dialogue that contributes to policy fine-tuning.

Given the systemic nature of ICT policies, their impact might extend beyond the domains they are intended to affect. The statistical analysis of the policy impact on investment indicate that initiatives such as Local Loop Unbundling, while allowing for a temporary stimulation of broadband development, have a chilling effect on forward-looking investment in infrastructure. Along these lines, a good management practice in policy implementation requires that all measures are evaluated and constantly monitored in terms of their holistic impact.

7. DEMAND-SIDE POLICIES AS KEY TO ADDRESSING THE DIGITAL INCLUSION:

In addition to deploying policies to stimulate infrastructure development aimed at achieving wide service coverage of key technologies, leading information societies implement several demand-side policies aimed at promoting ICT adoption. Recent research regarding the development of information societies has identified a significant demand gap, defined as the population that is served by information technology (principally broadband) but do not purchase service. In the United States, for example, the demand gap amounts to 31 % of households, in Germany it is 40 % and in Australia 20 %. On the other hand, in two of our country case studies, the demand gap is significantly lower: in Korea it is 7 % while in Sweden it is 11 %. A reduction of the demand gap is associated with the implementation of a series of policies aimed at reducing digital exclusion.

Governments of high-performance ICT sectors tend to introduce tax incentives designed to facilitate the purchase of equipment. For example, the Swedish government has decreed that 50% of the costs of broadband deployment are deductible up to a maximum of 5000 SEK for businesses and residential taxpayers who sign up for broadband services. Similarly, in Japan, firms investing in ICT solely for their own use have an option of either 10 per cent credit from corporate tax or special depreciation equivalent to 50 per cent of the acquisition cost.

By actively developing e-government services (electronic submission of tax returns, an e-procurement service for small and medium enterprises selling goods and services to the government, platforms for tele-commuting, and the development of platforms that allow the interaction between the government and enterprises for e-business transactions), the Korean and Estonian governments have provided additional incentives for consumers and small businesses to join the information society.

This initiative is generally complemented with the implementation of digital literacy programs comprising subsidies for acquiring PCs, and online education programs targeted to the elderly and disabled, such as the programs implemented in Korea. In the case of small businesses, the Japanese government encourages small and medium enterprises to voluntarily install new IT platforms to reform business management and improve productivity by providing training, collecting and disseminating best practices and supporting collaboration with local communities.

A particular area that has gained attention in demand-side policies is the much-needed support promoting ICT adoption and assimilation among Small and Medium Enterprises. They represent the center of gravity of most economies in terms of employment generation and, in many emerging countries, contribution to GDP and exports. Yet their level of technology sophistication is low, reflecting limited training, economic constraints for purchasing ICT products and services, and a general conservative attitude toward business innovation.

The policies toward stimulating ICT demand among SMEs vary by government. In Japan, for example, as a part of the SMEs Strategy Plan, the government created the IT Management Support Team, a public-private sector partnership network. Its aim is to encourage SMEs to voluntarily implement IT management to reform business management and improve productivity. The IT Management Support Team assists local SMEs by providing training, collecting and disseminating best practices and supporting collaboration with local communities. In Korea, an e-procurement service for SMEs selling goods and services to the government was implemented. In addition to government sponsored initiatives, the *chaebols* played an important role in stimulating adoption among small and medium enterprises. The large conglomerates developed programs that forced their SME suppliers to adopt the necessary eCommerce and broadband platforms if they wanted to continue being part of the supply chain of large firms.

8. SUPPLY-SIDE POLICIES THAT DRIVE THE TRANSITION TOWARD INFORMATION SOCIETIES:

In Section 5 above, we emphasized the notion that countries that have succeeded in building a high-performance ICT sector have transitioned from developing policies on a sector-by-sector basis (telecommunications, software, science and technology, computing) to an integrated comprehensive mode. While a comprehensive approach to ICT policy development recognizes

the interconnected domains of ICT (infrastructure, demand, production, and adoption) and sectors (telecommunications, applications, and devices), it is also characterized by integrating a set of policies affecting the supply of software applications, particularly eGovernment, the promotion of ICT-enabled services in the areas of education and health, and the protection of privacy.

Each of these areas can be shaped by public policies promoting their deployment and societal impact. In this domain, public policies assume a different orientation: from the regulatory philosophy aimed at creating sustainable competition to the promotion of supply based on a collaboration of the public and private sectors. Along these lines, while telecom policies tend to focus on the state regulating the activity of private firms and addressing market failures, non-telecom ICT policies aim at creating a partnership within which the government and the private sector tend to cooperate toward building the ICT eco-system. The case studies of Korea, Japan, and Estonia (in addition to the experience of Finland) are paradigmatic in this regard.

What are the specific policies that should be put in place to promote the development of eGovernment, eEducation, and eHealth? These are services that the government is particularly involved in delivering to the population-at-large, and their full potential cannot be realized unless policies are in place to equip the population to take advantage of them. Other studies that are part of this project have examined the experience of a wide variety of countries to see what specific government actions in these ICT-enabled areas have so far had a measurable impact on the intended outcomes of these activities. The general finding has been that it is too early to see measurable impacts on a society-wide level – partly because incorporation of the technology into provision of these services is at an early stage, and partly because developing the processes for effective use of the technology appears to be much more complicated than simply providing the necessary hardware and telecommunications services to the end users. In the health area, countries are at very different stages of adopting electronic health records systems, for example, partly because of the privacy challenges such systems face. Yet for the countries that have adopted such systems, the benefits have not yet made a measurable impact on the overall health and mortality of the population or total health care spending. The most noticed impact of ICT in the health arena is the change in the doctor-patient relationship – patients are now armed with knowledge that allows them to challenge their doctors' conclusions and discuss treatment alternatives. This knowledge also allows patients to, in effect, provide themselves with care and thus adds to the total resources available to deal with medical conditions. The policy implications of these findings emphasize the need for careful micro-level research into the impact of specific technology initiatives, since the impacts may find hard to find simply by measuring aggregate population indicators.

In the eGov arena, the most important demand-side factors promoting internet-enabled services appear to be the same factors that promote internet use generally – access to internet services and the knowledge and hardware necessary to gather information and implement transactions. In that regard, the prevalence of ecommerce and egovernment services go hand-in-hand. Strong government priority on general ICT provision to the population appears to be key.

Finally, the systematic impact of ICT in the education arena appears to be largely its impact on students' attitude toward science and math, which, in turn, affects their performance. Intensive use of computers at home appears to conflict with educational performance, however, since such use is often for entertainment that reduces the time spent on schoolwork. So far, the use of entirely new models of learning centered on student-computer interaction without the benefit of classroom instruction do not generally appear to be effective. Maximizing the benefit of ICT in the education arena will depend on continued research and experimentation to find the most useful and scalable ways in which it can improve the learning process.

9. CONCLUSION:

This chapter has not only provided evidence of how important public policy is to develop a high-performance ICT sector. It has also summarized a set of practices followed by some of the top performing countries in the world regarding their sector development. It also has become apparent that the type of policies and practices might differ across countries, depending on the type of political system. For example, China's political context has an influence on the ICT policy domain. Nevertheless, it is important to emphasize that regardless of the specificities of the political system, best practices are surprisingly common across nations.

A combination of statistical and qualitative case study findings have yielded support to the need to generate the right policy and regulatory conditions that result in sustainable competitive models, which are characterized by moderate concentration and infrastructure-based competition. At the same time, governments need to continue being involved in guiding the development of the sector. Comprehensive and integrated planning processes, top leadership and disciplined follow-up are some of the best practices identified. National plans need to reflect as well a social and political consensus of the technological goals to be achieved. Planning alone is not sufficient. High-performing ICT sectors complement multi-year integrated planning efforts with disciplined follow-up combined with ownership and accountability residing at the highest levels of government.

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Policy and Development of ICT
Appendix: The Impact of Public and Regulatory Policy on ICT Sector Performance: Statistical Analysis

By Raul L. Katz (Columbia University)

1. Introduction:

The purpose of this paper is to present a set of quantitative analyses conducted in order to establish the influence that policy and regulatory variables can exert on the performance of the ICT sector. The assessment of causality is conducted with the purpose of responding to a number of critical questions:

- What is the impact of the policy framework on ICT diffusion/adoption? How do models of regulation and public policy in the ICT sector condition specific sector performance?
- Which of those policies and frameworks are consistently associated with above par sector performance? Why are some countries more effective than others in implementing policy tools?
- What are the regulatory and policy issues influencing ICT outcomes in mature and emerging markets? What explains the trends in the evolution of policy?
- Can we draw a consistent set of policy factors yielding positive performance outcome?
- Do markets with more open, stable and predictable regulatory environments yield more robust ICT sectors?
- What non-regulatory policy initiatives successfully promote dissemination of ICT, and how does their success depend on the policy and regulatory framework?
- Are there any specific variables acting as influencers, enablers and obstacles of potential policy and regulatory frameworks? What institutional arrangements and policy frameworks are better suited to maximize ICT sector performance?

We recognize that, given data limitations as well as the complexity of some of the relationships, it might not be possible to fully ascertain the impact of policy on performance. This is the reasonthe conclusions to be derived from this analysis need to be combined with qualitative case studies of specific country or policy situations which could serve to either validate the quantitative findings, or complement our perspective with the rich combination of analytical techniques. The case studies have been selected with the help of the quantitative analysis and will be the subject of the next paper.

The statistical analysis focuses on three areas. We begin by conducting an aggregate quantitative assessment of impact of all policy and regulatory variables on sector performance, following three steps:

- Building of a sector performance index which measures the level of development of a telecommunications sector,
- Construction of a policy index which synthesizes the stage of development of a country's policy environment, and
- Assessment of the relationship over time between the policy and the performance indices.

This analysis allows us to identify the policy variables that have an impact in dramatically improving the performance of ICT sectors of certain countries. Furthermore, it will be possible to identify different developmental paths according to country/region-specific changes in the policy framework.

To complement the aggregate analysis, we conducted two sets of econometric analyses on specific policy impacts. First, we studied the policy variables that are more or less conducive to stimulate the investment in Next Generation Networks (e.g. fiber optics in the local loop). Second, we specified a model aimed at establishing the policy variables driving innovation in telecommunications services. In this case, our dependent variable was consumer adoption of mobile broadband services.

Each analytical module allows the identification of relevant case studies to complement, validate or provide exceptions to our quantitative analysis.

2. Theoretical Framework for Assessing Policy Impact on Sector Performance:

2.1. The components of ICT policy:

The policy variables that affect sector performance have multiple dimensions, ranging from regulatory to institutional, both either specific or not to the ICT sector. For purposes of our quantitative analysis, we have grouped policies in three clusters[13]: 1) the institutional framework, 2) the regulatory framework, and 3) non-sector specific policies which can have a spillover effect on the ICT sector.

The institutional framework variables comprise the factors assessing the interrelationships between the governmental entities that are in charge of developing policy or regulating the sector and the providers of service. For example, the variables included in this cluster comprise the overall institutional environment (e.g. scope and scale of national regulatory authorities (NRA), enforcement powers, dispute settlement, effectiveness of appeals), the separation between incumbent and regulatory activities, regulatory independence (e.g. autonomy, accountability, clarity of roles, and transparency of process), the existence of an overarching telecommunications law, and the privatization or not of the incumbent service provider.

The regulatory framework cluster comprises all the variables related to policies and regulatory approaches. They include market entry regulation (e.g. vertical separation, local loop unbundling, rights of way, numbering scheme, spectrum management), price regulation (interconnection, mobile termination rates, weighted average cost of capital, retail pricing), investment incentive regulation (e.g. asymmetry), the NRA's regulatory process (e.g. market analysis ex-ante), and the application of regulation by the NRA (e.g. technological neutrality, operational conditions, compliance monitoring).

Finally, non-sector specific policies that can have an impact on the performance of the ICT sector comprise variables such as direct foreign investment restrictions affecting market entry and capital structure, other trade restrictions affecting services supply, proactive long term

[13] Detailed descriptions of each cluster have been included in the review of the research literature included in appendix.

government planning, and regulation of audiovisual content affecting convergence (e.g. restrictions of telecommunications carriers regarding content distribution).
A systematic assessment of these policy clusters requires a formalization of those variables for which comprehensive data sets can be constructed:

- **Institutional framework,**
  - Regulatory independence: Degree in which the regulator is independent from the operator(s) and the Ministry,
  - Privatization stages Degree of incumbent privatization,
  - Industrial and/or development plan: Participation of the government developing strategies pro-ICT development,
- **Regulatory framework,**
  - Level of competition: Partial, managed or full competition for each telecom service,
  - Universal Service Obligations: Universal policies in place by specific service,
  - VoIP regulation: Framework allowing usage of VoIP services,
- **Non-sector specific variables,**
  - Ownership restrictions over wireless, value-added services and ISPs: Restrictions on capital structure of service providers by service, and
  - Fixed line ownership restrictions: Restrictions on capital structure of incumbent fixed line operator.

More specifically, in order to categorize a country policy environment, each country needs to be evaluated along a series of variables: (see figure 1)

Figure 1. The components of ICT policy

Clusters	Policies	Alternatives
Institutional Framework	Regulatory independence	• The regulatory authority is independent in terms of finance, structure and decision making from the operator(s) and the Ministry of Communications • The regulatory authority is autonomous in decision making
	Privatization stages	• State-owned company • Up to a 50% of the company is owned by private shareholders • More than 51% of the company is owned by private shareholders, but the government still holds shares of the company • The privatization is complete
	Industrial and/or development plan	• Is there a digital plan? Is it revised periodically? • Is there a comprehensive ICT strategic plan? Is it revised periodically? • Are there demand-side incentives and an ICT oriented industrial policy?
Regulatory Framework	Level of competition	• Services (fixed, wireless, broadband, VAS, etc.) under partial, managed or full competition
	Universal Service Obligations	• Does universal services/service policy exist? • Which services are covered by USO (wireline, broadband)? • Which operators are under USO (incumbent, all)?
	VoIP regulation	• Is VoIP service allowed? • Is there a VoIP regulation in place?
Non-sector specific variables	Wireless,VAS, ISP ownership restrictions	• Are foreigners prohibited from holding shares in an operator? • Are foreigners allowed to own up to 49% of an operator? • Are foreigners allowed to own more than 49% of a company, but a national partner is required? • There are no restrictions on foreign ownership
	Fixed line ownership restrictions	• Are foreigners prohibited from holding shares in an operator? • Are foreigners allowed to own up to 49% of an operator? • Are foreigners allowed to own more than 49% of a company, but a national partner is required? • There are no restrictions on foreign ownership

The review of the literature also allowed the formalization of four stages of development of ICT policy across these variables. These stages have been defined not only according to the level of competition but also whether in the later policy development stage, the government is defining

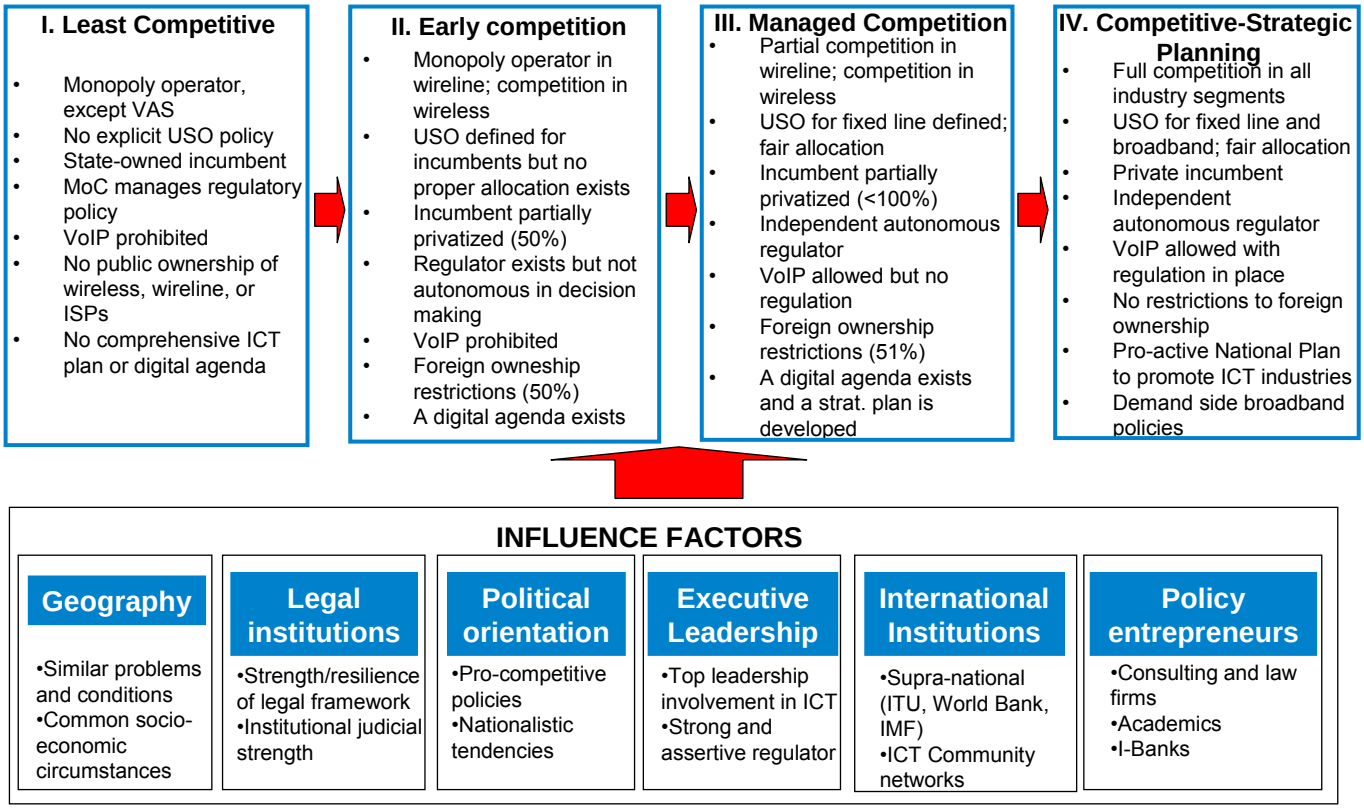
a strategic plan for growing the ICT sector and maximizing its socio-economic impact. In particular, policies that promote and facilitate the adoption of ICT by late adopters (socio-economic disenfranchised and small and medium enterprises), such as digital literacy programs and equipment subsidization, play an extremely important role in fostering the emergence of a high performance sector (see figure 2).

Figure 2. Stages of ICT Policy development Impact

Cluster	Policies	Stage I Least competitive	Stage II Early competition	Stage III Managed Competition	Stage IV Competitive / Strategic Plan
Institutional Framework	Regulatory independence	MoC manages regulatory policy	Regulatory agency exists within MoC but is not autonomous in decision making	An independent regulator exists and is autonomous in decision making	An independent regulator exists and is autonomous in decision making
	Privatization stages	State owned	Partially private (50%)	Partially private (<100%)	Fully private
	Industrial and/or development plan	No agenda or digital plan exist	A digital agenda continuously updated exists	A digital agenda exists; a strategic plan is under development	Pro-active National Plan to promote ICT industries exists
Regulatory Framework	Level of competition	Monopoly operator, except VAS	Monopoly in wireline; competition in wireless	Partial competition in wireline; competition in wireless	Full competition in all segments
	Universal Service Obligations	No explicit USO policy	USO defined for incumbents but no proper allocation mechanisms exist	USO defined for wireline, fair allocation mechanisms exist	USO covering fixed line and broadband; fair allocation mechanisms exist
	VoIP regulation	VoIP prohibited	VoIP prohibited	VoIP allowed but no regulation in place	VoIP allowed, with regulation in place
Non-sector specific variables	Wireless,VAS, ISP ownership restrictions	No competition; no public ownership	Ownership restrictions apply to foreign investors (50%)	Ownership restrictions apply to foreign investors (51%)	No restrictions to foreign ownership
	Fixed line ownership restrictions	No competition; no public ownership	Ownership restrictions apply to foreign investors (50%)	Ownership restrictions apply to foreign investors (51%)	No restrictions to foreign ownership
	Demand-side policies	Not existing	Implementation of telephony Universal Service Fund	Deployment of public access facilities for broadband	Promotion of ICT adoption and applications usage by SM&E Universal broadband policies

It is understood that countries move from one stage to the next driven by a set of either tangible or intangible idiosyncratic factors (see Hoffman et al., 2009): legal system, political culture, level of economic development, linkage to a network of international policy influences (e.g. Commonwealth countries) (Katz, 2009). By including those factors, a comprehensive conceptual framework of ICT policy development can be drawn (see figure 3).

Figure 3. Conceptual framework of ICT policy stages



As the conceptual framework indicates, the adoption of ICT Policies is influenced by a number of tangible and intangible factors. The geographic influence appears to be relevant in terms of either location proximity or countries sharing common socio-economic circumstances which results in adoption of policies addressing similar problems and conditions. Similarly, the role of institutions and policy entrepreneurs acting as networks of influence is important in leading countries to move from one stage to another. Finally, the political environment, both in terms of economic policy orientation and executive leadership have a significant influence on the direction and speed of change.

The emphasis on the quantitative analysis, however, will be less so on the analysis of influence factors driving countries to move from one stage to the next and more on how each of these stages impacts ICT sector performance. Many of the influencing variables are less tangible and therefore less subject to adequate measurement. As such, they will be better captured by the case studies that complement this work.

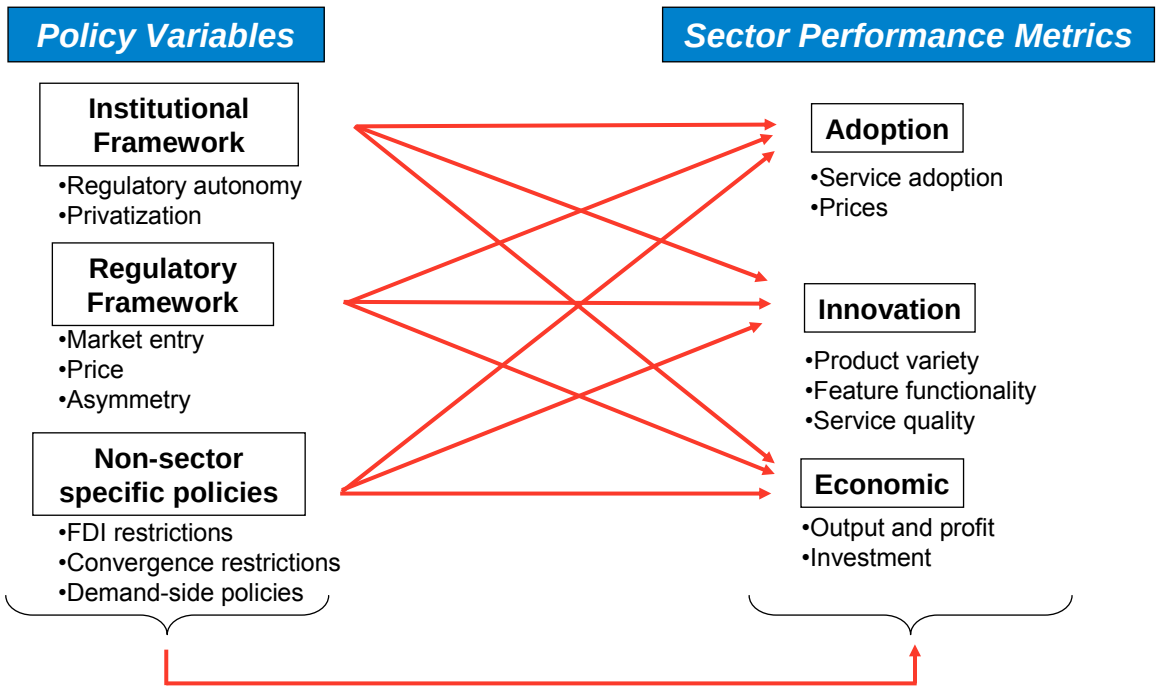
2.1. The impact of ICT policy on sector performance:

The three clusters of policy variables can have an impact on sector performance, which was measured along three types of independent variables: 1) telecommunications service adoption, 2) product innovation, and 3) economic performance.

Service adoption variables measure not only penetration (e.g. broadband subscribers per population or households, wireless subscribers per population), but also pricing trends that can stimulate adoption via demand elasticity (e.g. broadband subscription, wireless service revenue per minute, etc.). Innovation variables focus on product variety, feature functionality and service quality. They can be measured through indicators such as percent of mobile ARPU (average revenue per user) derived from data services, quality of service (in mobile services, dropped calls, service coverage; in wireline services, mean time to repair, number of faults per total access lines), etc. Finally, economic performance variables comprise industry output and profits (revenues and EBITDA margins), and capital investment.

Once the variables have been defined, the review of the research literature allowed for categorizing the evidence that has been generated so far in support of the causality of these multiple relationships (see figure 4).

Figure 4. Causal links between policy and sector performance



First, the research literature reviewed provided evidence regarding the impact of the institutional framework on service adoption and sector economic performance. For example, regulatory autonomy has a positive impact on wireless prices and penetration, privatization of state-owned monopolies has a positive statistically significant effect on sector performance (Bouras et al., 2009) and improved institutional framework (e.g. independent NRA, lower

corruption, contract enforcement) leads to better performance (Maiorano et al., 2007; Waverman et al, 2007)

Second, the regulatory framework, particularly specific policies, has significant impact on telecommunications service adoption and sector economic performance. For example, competition in wireline has a positive statistically significant impact on network deployment (Li et al, 2004; Grzybowski, 2008; Wallsten, 2001). In the case of wireless, the policy framework was found to have an impact on the diffusion and pricing of wireless services. For example, competition and number portability (when combined with regulatory autonomy) have a positive impact on wireless prices and penetration, while number portability has a negative impact on prices (Maiorano et al. (2007); Grzybowski (2005)).

In the case of broadband, access regulation discourages investment by incumbents and individual entrants even as entrants total investment increases. With very few caveats, platform-based competition appears to be the key variable explaining broadband deployment, as concluded by Distaso et al. (2006), Cava-Ferreruela et al. (2006), Boyle (2008), Wallsten (2006) and Garcia-Murillo (2005) (although in this case for high income countries). Lee et al. (2008) determine that the impact of platform-based competition is stronger when the share of technologies reaches parity (this related to competitive intensity). Waverman et al. (2007) determined that unbundling tends to weaken facilities-based competition and reduce infrastructure investment. Conversely, most studies provide limited evidence on the importance of LLU in fostering broadband adoption. There is a small, statistically insignificant positive effect (Distaso, et al., 2006; Cava-Ferruela et al., 2006), and a small effect which is neither consistently positive nor consistently significant (Wallsten, 2006). Bauer et al. (2004) was the only study that failed to identify an impact of competition policy on broadband penetration, although this could be related to the early time at which the research was conducted and very preliminary data sets, while Ford and Spiwak (2004) determined that unbundling prices had a positive impact on broadband availability.

Beyond these findings, our research literature review also found that the impact of policy on level of innovation as well as the comprehensive impact of all policy variables on sector performance has not been yet analyzed. More specifically, research on the assessment of the impact of regulation and policy variables on rate of sector innovation is nonexistent. Similarly, there is limited analysis on the impact of trade regulation on sector performance. Finally, there is no comprehensive study between all regulatory and policy variables and full sector performance. This has led us to focus our quantitative analysis in the areas that require additional insight in terms of the relationship between policy and sector performance:

- What is impact of aggregate policy and regulatory initiatives on sector performance?
- What is the impact of the institutional and regulatory variables on innovation?
- What is the impact of non-sector specific variables on sector performance?

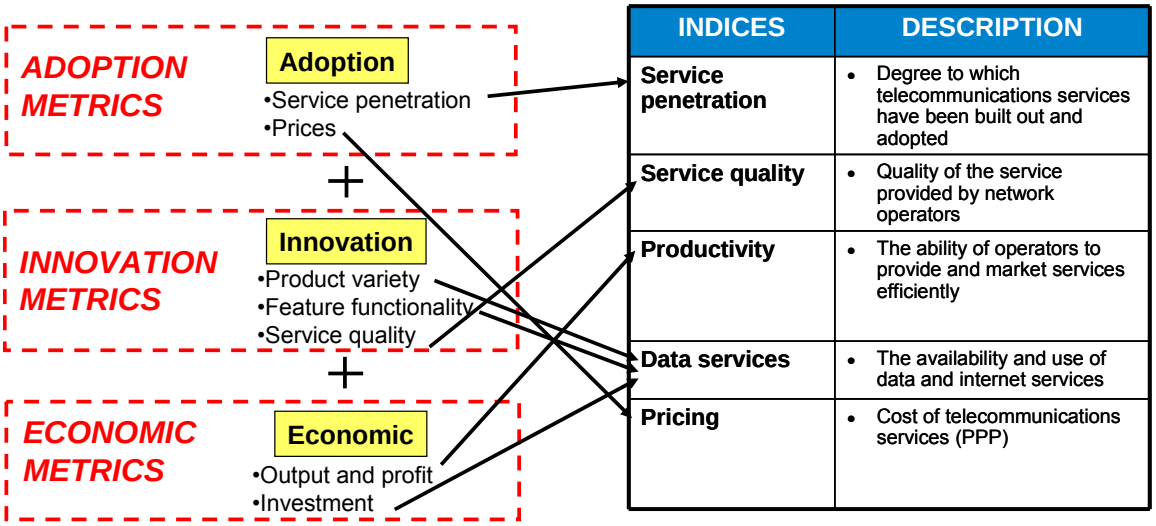
However, in order to study the policy impact on sector performance, we need to first define an approach to measure this in the aggregate.

3. Measuring Sector Performance:

3.1. Development of ICT Sector Performance Index:

To assess impact of policy variables on the ICT sector, the creation of an index measuring sector performance was required. Following the theoretical framework described above, the development of a performance index covered the areas of service adoption, innovation and economic performance. Each area was decomposed in several indicators (see figure 5).

Figure 5. Sub-Indices comprising the ICT Sector Performance Index



INDICES	DESCRIPTION
Service penetration	• Degree to which telecommunications services have been built out and adopted
Service quality	• Quality of the service provided by network operators
Productivity	• The ability of operators to provide and market services efficiently
Data services	• The availability and use of data and internet services
Pricing	• Cost of telecommunications services (PPP)

Each sub-index was built by aggregating several metrics:

- Service penetration: fixed telephony lines (per 100 population), wireless subscribers (per 100 population), fixed broadband lines (per 100 population),
- Service quality: fixed line faults per 100 lines, percentage of telephone faults cleared by next working day,
- Productivity: full time telecommunications staff (per fixed lines and mobile subscribers), wireless telecommunications staff (per mobile subscribers), fixed line minutes (Local + LD)/ number of access lines,
- Data services: mobile Broadband Penetration, wireless data as a percent of ARPU, FTTH penetration (percentage of fiber in broadband connections), and
- Pricing: price of mobile service (monthly charges) as proportion of GDP per capita, price of variable costs of mobile services (90 minutes of peak time), price of fixed line service (monthly charges) as proportion of GDP per capita, fixed line services basket as proportion of GDP per capita (annual basis) [Installation costs+12*(monthly costs+90minutes of peak time)], price of broadband (Mbit / US$) PPP.

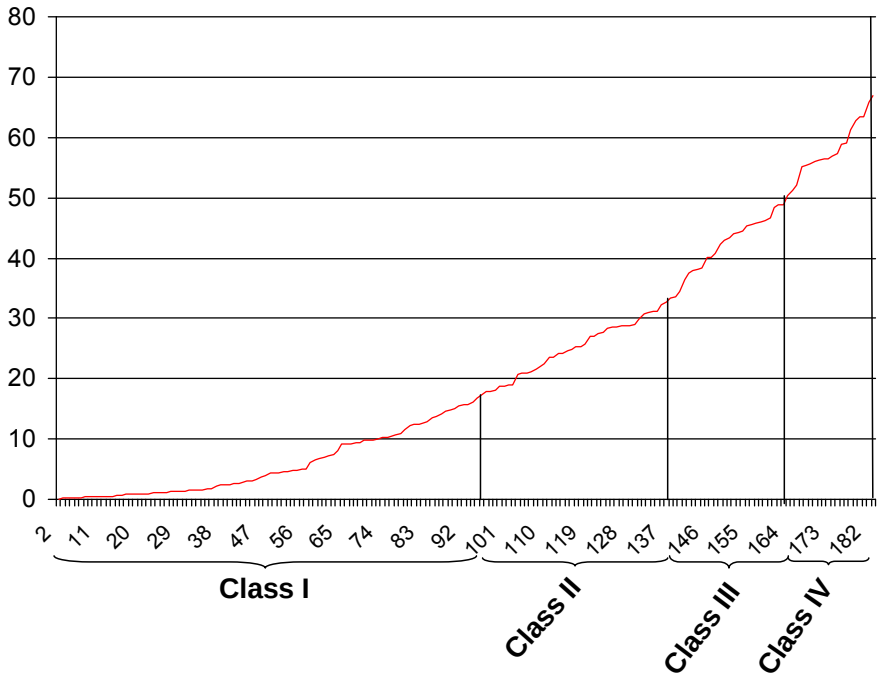
Data for each metric was retrieved from four international sources (ITU, 2009); OECD, 2009; Merrill Lynch, 2009; IDATE, 2009) supplemented with country regulatory authority data bases and company reports. Assuming a normal distribution for each metric, the data sets were divided in four performance categories. As an example, in order to generate the cut-over points

for fixed telephony line penetration, we normalized the data set, eliminated the outliers (e.g. Gibraltar, San Marino, Bermuda), and defined the class limits by dividing the distribution in a uniform manner. This was done by determining minimum and maximum of the normal distribution and defining cut-over points for four classes within the normal distribution according to the following formula:

Minimum value = Percent * (Max-Min) + Min.

With this, the cut-over points for each performance class were defined (see figure 6).

Figure 6. Normal Distribution and Cut-over Points for Fixed Telephony Penetration



Based on this methodology, four "levels" of telecommunications sector relative performance were defined (see figure 7).

Figure 7. ICT Sector Performance Levels Figure

	Level 1 Rudimentary	Level 2 Emerging	Level 3 Advanced	Level 4 World Class
Service penetration				
● Fixed telephony lines	0-19%	17-32.9%	33-50%	>50%
● Wireless subscribers	0-25.9%	26-49.9%	50-75%	>75%
● Fixed broadband lines	0-9.99%	10-19.9%	19.9-30%	>30%
Data services				
● Mobile Broadband Penetration	0-17.9%	18-35.9%	36-54%	>54%
● FTTH penetration	0-2.99%	3-5.9%	6-9%	>9%
Wireless data as a percent of ARPU	0-14.4%	14.5-22.5%	22.6-30%	>30%
Pricing (as portion of GDP per capita)				
● Variable Costs of mobile services	>0.83%	0.83-0.57%	0.56-0.29%	< 0.28 %
● Monthly Costs of mobile service	>0.11%	0.11-0.08%	0.07-0.05%	< 0.04 %
● Annual Costs of fixed line services	>8.98%	8.98-6.00%	5.99-3.00%	< 2.99 %
Price of Broadband (Mbit/US$ PPP)	$ >24.66	$ 24.66-16.73	$ 16.72-8.80	$ <8.79
Service quality				
● Fixed line faults per 100 lines	>72%	72-48%	47-24%	<23%
● Percentage of telephone faults cleared by next working day	0-28.9%	29-52.9%	53-75.9%	76-100%
Productivity				
● Number of Lines per Full time telco staff	0-305 0-1402	306-503 1403-2612	504-701 2613-3823	>702 >3824
● Subscribers per Wireless telco staff				
● Fixed line minutes (Local + LD)/ number of access lines (Annual)	0-3292	3293-6542	6543-9791	>9792

With this framework, we calculated the performance level for each indicator and the performance composite index for each nation for the year 2008. If the value for an indicator of a country is within a certain class range, the number for the corresponding class was applied (for example, the fixed line penetration for the United States is 51.8%, meaning that fixed line density is 51.8 per 100 population; since 51.8% falls within Class IV, the value assigned to the United States in this indicator is 4). Once the values were assigned to each indicator, the performance index was calculated as an average of all indicators. The implicit assumption of equal weights across indicators was made to avoid any subjectivity in the formulation of the index[14].

[14] Note: if one country does not have information on an indicator, this is excluded from the calculation of the composite index

3.2. Comparative ICT Sector Performance analysis:

Once all countries were ranked according ICT sector performance, we started drawing some conclusion across the sample. As of 2008, only three countries in the world (Sweden, Korea and Japan) had reached "level 4 - World Class." A world-class country typically exhibits high adoption of all telecommunications services, high service quality and productivity. However, its differentiating features are high penetration of mobile data services, high deployment of fiber optics for broadband access and, consequently, faster download speeds for Internet access.

Twenty-one countries are ranked as "Level 3 – Advanced," including all industrialized countries (United Kingdom, United States, Denmark, Switzerland, Austria, Italy, Germany, Portugal, France, Finland, Spain, Iceland, Estonia, Slovenia, Czech Republic, Greece, Hungary, Slovak Republic, Belgium, Australia and Luxembourg). They exhibited high adoption of wireless and broadband services and while they have a profile similar to the "world class" countries, they lag with regards to the introduction of new services, such as wireless broadband and Next Generation Networks.

The "Level 2 - Emerging" countries comprise nations whose wireline penetration is relatively low, although they have reached this performance level due to leapfrogging the early developmental stages of voice telephony through wireless. Broadband adoption, however, remains moderate. The Level 2 is comprised of two tiers. On the one hand, the "developing" countries are relatively more backward with regards to ICT, while the "transitioning" countries are actively moving across the sector performance scale. The 25 "developing" countries comprise nations in Africa (Kenya, Cameroon) and Emerging Asia (Mongolia, Pakistan) while the 21 "transitioning" countries are generally situated in Latin America (Brazil, China, Mexico, Uruguay, Argentina) and Eastern Europe (Poland).

Finally, "Level 1 - Rudimentary" countries, numbering 17 are generally located in Africa (Central African Republic, Ethiopia, Togo, Benin, Mali, Rwanda, Ivory Coast) and Asia (Kyrgistan, Nepal). In these countries, adoption levels of wireless and fixed broadband are very low, while pricing of telecom services still represents a large proportion of disposable income.

3.3. Policy variables driving ICT sector performance improvement paths:

Beyond a static view of ICT sector performance, we have analyzed the evolution of sector performance for a selected group of countries between 1980 and 2008. Our objective was to identify independent policy variables that, in a holistic way, improve the performance of the ICT sector. To narrow down our analysis, we tackled five questions:

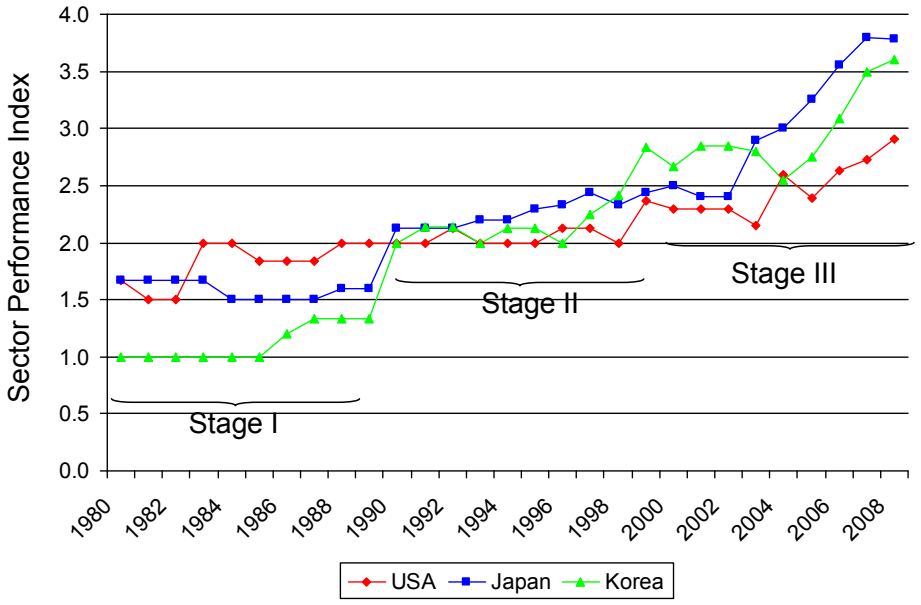
- How have Korea and Japan performed relative to other industrialized countries? What policy and regulatory variables explain their different relative performance?
- Is there a consistent performance improvement trend among Western European countries? If not, what explains divergent paths among them?

- How has the telecom sector of selected Eastern European countries (Estonia, Slovak Republic) performed relative to Western Europe? What explains changes in sector performance?
- Are the "BRICs" behaving homogeneously? Is there a consistent or a divergent development path across these four countries? Which policies are affecting performance or driving independent development paths within this group?
- What is the path toward enhanced sector performance across emerging countries like? Is there a consistent development path?

Each question will be answered in turn.

Figure 5 displays the historical evolution of the ICT sectors of the U.S., Japan and Korea in terms of sector performance, indicating how the telecom sectors of Japan and Korea have passed by the U.S, (see figure 8).

Figure 8. Evolution of sector performance: U.S., Japan and Korea (1980-2008)



A comparative analysis of telecom sector performance of the U.S., Japan and Korea between 1980 and 2008 indicates three clearly defined stages. Between 1980 and 1990, we can observe above-par performance of the US relative to Japan and Korea. Between 1990 and 2000, the situation changes, and the three countries display comparable performance levels. Finally, starting in 2000 throughout 2008, Japan and Korea move ahead of the U.S.

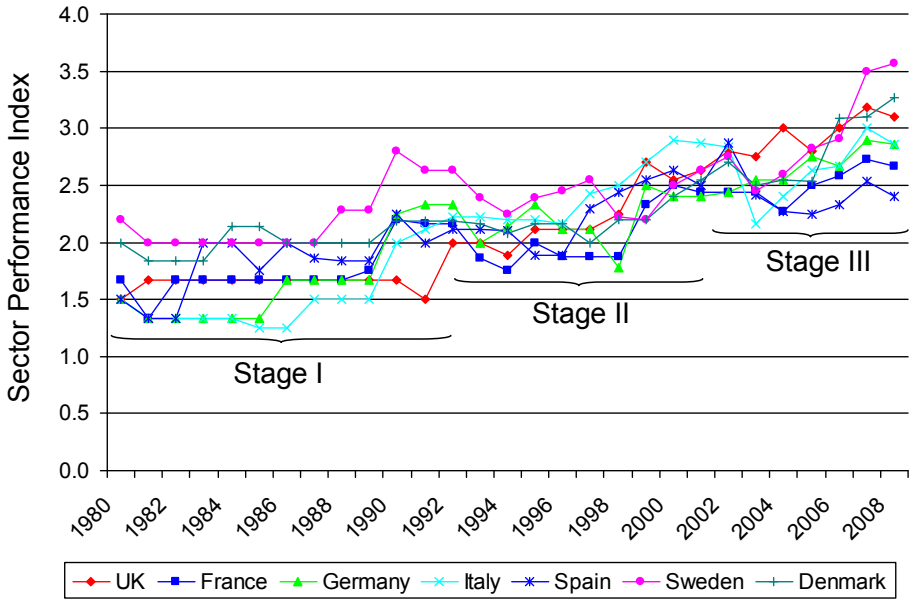
Several policy variables explain this change in leadership position, although in both cases, an industrial policy guided by a vision of the country's technological future appears to be the guiding factor. In Japan, in 1994 the government sponsored wireless internet standard which triggering intense product development and adoption. A year earlier, the government allowed cable companies to offer broadband beyond their franchise, thereby encouraging platform-based competition in broadband. Four years later the government fostered FTTH (Fiber to the

home) deployment by allowing telecommunications carriers to offer pay-TV only if they deployed fiber networks. In addition, in order to support carriers that deployed fiber in the access loop, the Japanese Development Bank started in 2001 providing “soft loans” for deployment of NGN.

In the case of South Korea, the process of sector advancement started with the privatization of Korea Mobile Telecom in 1994. In 1996, the wireless market was completely liberalized triggering entry of several new players. In 2002, the government allowed the consolidation of the mobile market in order to enhance the carriers' investment capacity. In parallel with the development of a sustainable wireless sector, the government pursued several initiatives to encourage the deployment of fiber optics in support of broadband services. In 1997, the government created the Cyber Building Certificate leading to reduction in fiber deployment costs, while in 2001 the government provided funding of $ 1.5 billion for broadband deployment.

The example of Japan and Korea is repeated when comparing the development of Sweden and Denmark ICT sectors with that of their Western European counterparts (see figure 9).

Figure 9. Comparative Evolution of ICT Sector performance in Western Europe



Similarly to the case of Japan and Korea versus the U.S., a comparative analysis of the sector performance of Western European countries exhibits three stages. Between 1980 and 1994 (Stage I), Sweden and Denmark outperform the rest of Western European countries. Between 1994 and 2003 (Stage II), all countries tend to perform fairly uniformly within a .5 range of the performance index, while between 2003 and 2008 Sweden, Denmark and the U.K. regain their leadership of the group, while Italy, France and Spain recede.

Several policy variables explain the continuous leadership position from the two Scandinavian countries in the first and last decade. Four public policy initiatives explain Sweden's superior performance:

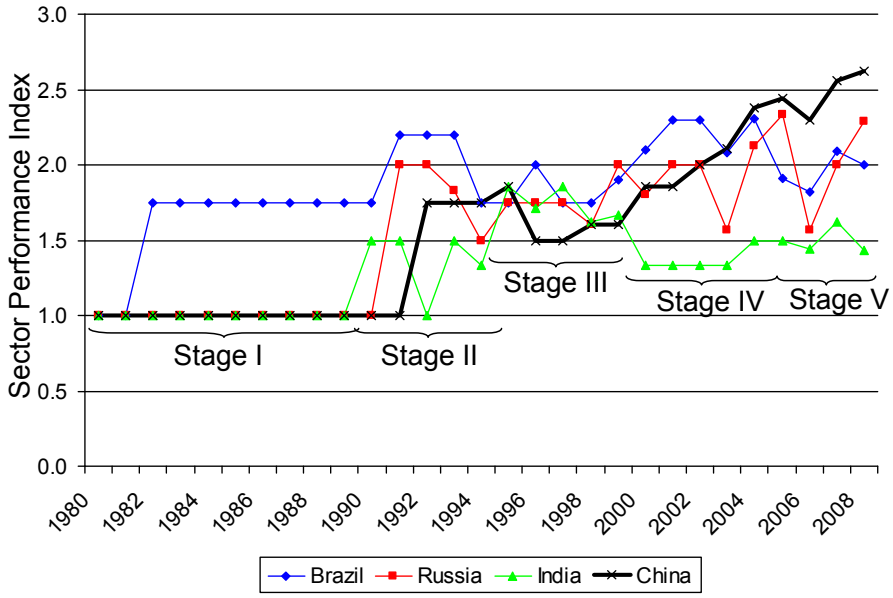
- Government financially supports the deployment of broadband in rural areas;
- Public investments in a backbone network and government support of ‘‘open’’ and ‘‘operator neutral’’ local and regional networks;
- Subsidies and tax allowances and other demand promotion tools to stimulate broadband adoption, and
- Active promotion of platform-based competition by cable operators and alternative carriers.

These four policies were implemented in the context of a vision and strategy formulated early on by the Swedish government[15].

In the case of Denmark, price-cap regulation on end-user tariffs was introduced alongside interconnection regulation in 1995. In addition, with the full liberalization of Danish telecommunications market, the government shifted from services-based competition to platform based competition approach. Similarly to the case of Sweden, broadband adoption was stimulated with the help of fiscal incentives for PC adoption, introduced in 2002.

Consistency in the application of specific national telecommunications policy strategies also helps explain China's surprising progress vis-à-vis its peers in the "BRIC" group (see figure 10).

Figure 10. Evolution of ICT Sector Performance: China versus BRICs

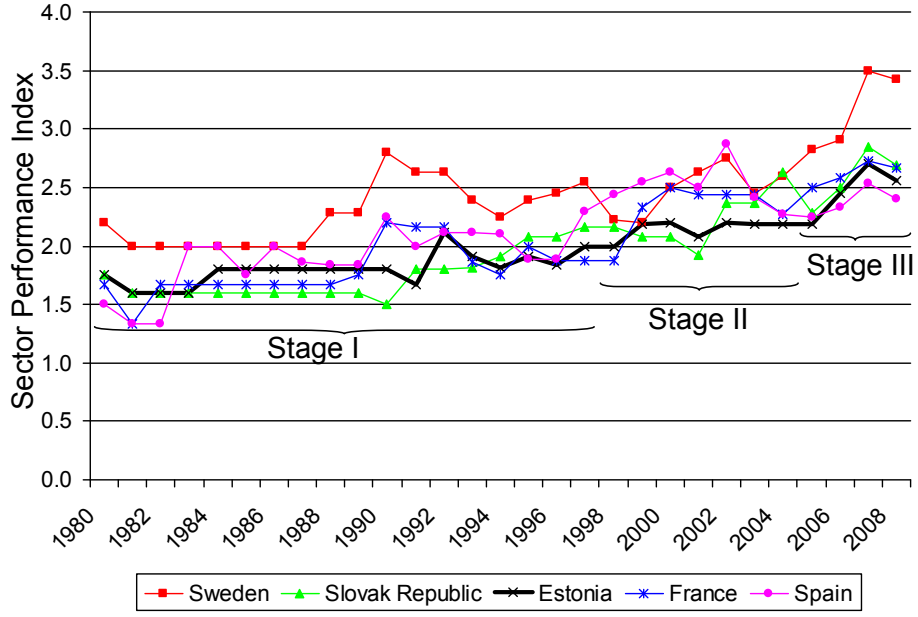


[15] For further detail, see the Sweden case study.

A comparative analysis of telecommunications sector performance of the BRICs between 1980 and 2008 indicates how, after 2004, the Chinese telecommunications sector starts to display superior performance compared to the rest of the "BRICs". Several policy variables explain this change in performance. In the mid-1990s, the Chinese government encouraged the state-owned incumbent carriers to expand basic network coverage and lower the cost of service in order to increase penetration and usage. This was combined with implicit USO requirements with essentially mandated rollouts to uneconomic geographies (rural areas) since 2004. In addition, in order to protect the incumbent's market position, the government controlled market access for both local and foreign entrants, while enacting a regulatory approach aimed at yielding continuous tariff reductions and ever greater penetration and usage. In order to help carriers reduce the burden of ongoing capital requirements, the governments put pressure on international equipment providers and IP owners to continually lower prices and provide a global "best price" for China. Finally, recognizing the need to rationalize the market structure in 2008 the government allowed the reorganization of the telecommunications industry, reducing the number of players from 6 to 3.

Beyond clearly formulated overarching ICT policies (Korea, Japan and Sweden) and the promotion of universal service and incumbent protection (China), the case of some Eastern European countries highlights the importance of broadband demand stimulation programs (such as training and subsidies) and public-private partnerships. A comparative analysis of the historical performance of Estonia and the Slovak Republic versus some Western European countries indicates that, despite the lack of resources, the former were able to display comparable ICT sector performance to the latter (see figure 11).

Figure 11. Evolution of ICT Sector Performance: Eastern versus Western Europe

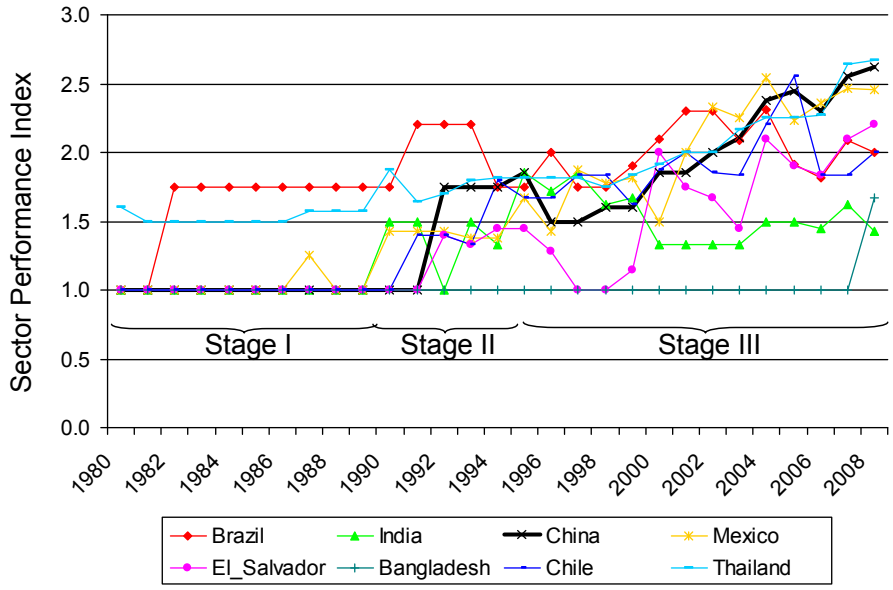


A comparative analysis of Eastern European (Estonia, Slovak Republic) sector performance versus selected Western European countries indicates three stages of development. Between 1980 and 1998, the Eastern Europe's telecom sector did not diverge substantially from the laggards in Western Europe (France and Spain). Between 1998 and 2003 the performance of France and Spain dramatically improved with regards to Estonia and the Slovak Republic, when the former matched the performance of the Swedish sector, the leader of Europe. After 2003 the ICT sector of Estonia and the Slovak Republic dramatically improves its performance, matching that of France and Spain, although the four underperformed relative to Sweden.

Several policy variables explain how the two East European countries were able to regain a parity position with Western Europe. In 2004 the government of the Slovak Republic launched a strategy aimed at achieving the ICT level of developed EU countries within the next 5 to 8 years. The strategy was predicated on effective utilization of common government-owned infrastructure (e.g. railways), government provision of direct subsidies to broadband internet users, and government funding of municipal FTTH networks.

In Estonia, emphasis was put on demand stimulation broadband programs. Between 1996 and 200, the government put in place a program to fund computers and broadband to 75% of school while training teachers in computer skills, In addition, between 2001 and 2006, the government emphasized the development of sustainable infrastructure through collaboration between state, local governments, schools, and community organizations.
In other emerging countries, the improvement of ICT sector performance was directly linked to incumbent privatization and the liberalization of wireless services (see figure 12).

Figure 12. Evolution of ICT Sector Performance: Emerging Countries



Between 1980 and 1990, emerging countries had, with few exceptions, a consistently underperforming telecom sector. After 1990, the sector improved and entered into a vector of consistent performance enhancement. However, the performance improvement trend is not homogeneous; some countries (Bangladesh, India) still underperformed the rest of the emerging market universe. Several policy variables explain this situation. For example, in the case of India, the liberalization of the wireless industry, enacted in 1994, was structured around 21 geographic areas, in each of which only one state-owned company could compete with a private company. The failure of the state-owned companies to achieve their service goals led to allowing more competition in 1999 by handing out more cellular licenses per area, the elimination of FDI restrictions in ISP providers, and allowing the entry of IP competitors. The initial misconception in wireless deregulation delayed the development of the Indian industry by five years.

In summary, the analysis has confirmed the influence of independent policy variables in driving sector performance; however, policies vary by geography. Figure 13 compiles all the policy variables identified as having had an important influence in driving ICT sector improvement.

Figure 13. Policy variables driving Performance Improvement

ANALYSIS	POLICY VARIABLES
How have Korea and Japan performed relative to other industrialized countries? What explains their different relative performance?	● Government-sponsored standards for wireless internet (Japan) ● Platform-based competition in broadband (Japan) ● Government funding of NGN deployment (Japan) ● Liberalization of wireless sector (Korea) ● Government funding of broadband deployment (Korea) ● Limited control of wireless service provider consolidation (Korea)
Is there a consistent performance improvement trend among Western European countries? If not, what explains superior performance of Sweden and Denmark?	● Promotion of IT clusters in rural areas (Sweden) ● Public investment in backbone and support of municipal fiber deployment (Sweden) ● Demand subsidies and fiscal incentives (Sweden and Denmark) ● Promotion of platform-based competition (Sweden and Denmark)
How has the telecom sector of Eastern European countries performed relative to Western Europe?	● Leverage of state-owned infrastructure for backbone (Slovak Republic) ● Subsidies for ICT adoption (Slovak Republic) ● Government funding on municipal fiber (Slovak republic and Estonia) ● Emphasis on demand-side programs and Public Private Partnerships (Estonia)
Are the "BRICs" behaving homogeneously? Why is China outperforming?	● Implicit universal service policies ● Protection of incumbents ● Government pressure on suppliers to reduce equipment costs ● Supplier consolidation
What is the path toward enhanced sector performance of emerging countries like? Is there a consistent development path?	● Privatization of incumbent wireline carrier ● Liberalization of wireless industry

The analysis of descriptive statistics presented above allows the identification of policies having an impact on the performance of the ICT sector. However, the quantitative assessment of causality between sector performance and policy requires the development of a policy index that can then be related to the sector performance index. The next section reviews the approach to the development of a policy index.

4. Developing a Policy Index:

The development of regulatory indices presents an analytical challenge since, while there are several readily available metrics measuring sector performance (adoption, pricing, capital investment, productivity), the measurement of regulation requires the researcher to deal with implicit subjectivity[16]. This is because the available indices try to measure the level or intensity of regulation in a country. If one wants to analyze if a policy relates positively or negatively to performance one cannot start assuming ex-ante the effect of a policy. Therefore, to evaluate the policy impact probably the more reliable approach would be to utilize discrete regulatory variables rather than a policy/regulatory index[17]. On the other hand, the index is particularly useful to assess, in a comprehensive manner, the state of policy development in a country and, in consequence, assert the impact on the development of ICT. Therefore, we decided to rely on an index when analyzing the holistic impact of a set of policies or regulations, while when trying to find out individual policy effects we decided to consider each policy or regulation individually.

Furthermore, rather than relying on one of the indices previously developed[18], we decided to develop a new one. To construct the policy index, the indicators discussed in section 2.1 were identified. Each country was assigned a score based on each of the policy options described in 2.1. (see figure 1).

These criteria allowed us to create a four-level policy index which ranks countries not only according the level of competition but also whether in the later policy development stage the government has defined a strategy for growing the ICT sector and maximize its socio-economic impact. Each country was ranked based on the qualitative information provided by the ITU Regulatory database, as well as information collected by the authors for the availability/development of an ICT Development Plan.

Once the dataset was completed (see appendix 1), we utilized three approaches to index construction in order to test its robustness:

- Factor analysis,
- Random weights method, and
- Linear un-weighted average.

[16] For instance, in question 99 of the ECTA scorecard, a popular index discussed in the research literature review in the appendix, the question of whether sub-loop unbundling is used in a country, is answered in the following way: if the answer is yes the highest weight is awarded, zero otherwise. Then, in order to construct the index, a weight is assigned. As we can see there are two stages that are susceptible to subjectivity, first when deciding what a "good policy" is and second the weight that a policy will be assigned to the indicator.

[17] Imagine an index with two variables. We can only estimate the effect of the index on the dependent variable. We cannot retrieve individual effects. (similar to the reduced form Vs. structural form problem)

[18] Each of the five indices reviewed in our prior paper have specificities. ECTA is more focused in assessing the regulatory and institutional frameworks, while REGUL (Gutierrez, 2003) measures institutional domains, Regulatory Density (Zenhausern et al., 2007) focuses on the regulatory framework and the Policy Index (Warren, 2000) and Height of Barriers (Lim et al., 2009) address trade restrictions primarily with a spill-over on regulatory framework. As a result, a comprehensive index will have to combine all three areas. We will therefore build a composite index, which combines elements of all four in terms of the three areas of focus. In order to deal with the subjectivity of weightings, we will rely on the robustness test conducted by Zenhausern et al (2007).

Factor analysis follows the approach utilized by the OECD to aggregate the indicators into a single policy index of Policy Market Regulation[19]. Following Nicoletti et al. (1999), factor analysis aggregates the discrete indicators ensuring that the resulting index accounts for a large part of the cross-country variance of the detailed indicators, while preserving the independence from subjective perspectives of the relative importance. The methodology aggregates detailed indicators into summary indices of regulation by means of factor analysis, in which "each component of the regulatory framework is weighted according to its contribution to the overall variance in the data."

The random weights method follows the methodology utilized by the European Commission in its first attempt to measure the quality of public finances in the EU[20]. This study proposes several options for the creation of a composite index, one of which is the development of random weights within a normal distribution relying on a random number generation process. The advantage of relying on random weights is that it completely eliminates any prior subjectivity regarding the relative importance of each variable. Furthermore, it also allows assessing the potential bias related to the choice of alternative weights.

Linear un-weighted average constructs the composite index by calculating a simple average of all the discrete indicators. This method's drawback is that it assigns an equal weight to all indicators and therefore assumes that all of them have the same level of importance in generating the composite index.

After calculating the policy index by relying on the three methodologies, we compared the results in terms of consistency and highlighted the cases in which rankings were sufficiently different among the methodologies.

[19] The OECD Product Market regulation indicators focus on assessing the relative friendliness or restrictiveness of regulation to market mechanisms

[20] See Barrios and Schaechter (2009).

Figure 14. Comparative Policy Index Rankings According to Three Weighting Methodologies

	Factor Analysis	Equal weight average	Random coefficients
Korea	1	2	4
Japan	2	12	11
Finland	3	7	7
United Kingdom	4	1	1
Chile	5	6	8
Sweden	6	13	12
Germany	7	14	16
Switzerland	8	16	15
Denmark	9	11	13
United States	10	4	2
Spain	11	3	3
Singapore	12	21	21
Norway	13	26	26
Belgium	14	23	23
Bangladesh	15	28	29
Netherlands	16	10	10
Ireland	17	8	6
Dominican Republic	18	5	5
Portugal	19	20	22
Austria	20	17	17
Slovak Republic	21	22	18
Brazil	22	18	20
Italy	23	9	9
France	24	19	19
Colombia	25	29	28
China	26	43	44
New Zealand	27	25	24
Iceland	28	24	25
Peru	29	15	14
Egypt	30	33	33
Israel	31	39	39
Ecuador	32	36	37
Canada	33	32	34
Slovenia	34	31	30
Turkey	35	34	32
Russia	36	40	40
Venezuela	37	38	38
UAE	38	47	46
Australia	39	35	35
Argentina	40	30	31
El Salvador	41	27	27
Guatemala	42	37	36
Uruguay	43	44	43
Mexico	44	41	41
Costa Rica	45	51	51
Thailand	46	49	49
Cameroon	47	46	47
Zimbabwe	48	50	50
South Africa	49	45	45
Honduras	50	52	52
Bolivia	51	42	42
Paraguay	52	48	48

The comparison among the three ranking methodologies indicates that the random coefficient methodology is highly consistent with the equal weight average, while reflecting no bias. As a result, the ranking based on random coefficients was selected as methodology for creating the policy index. The ranking based on this methodology indicates that, as of 2008, 12 countries had reached a level 4 (Competition-High level Planning), while 20 are at stages 1 or 2 (see figure 15).

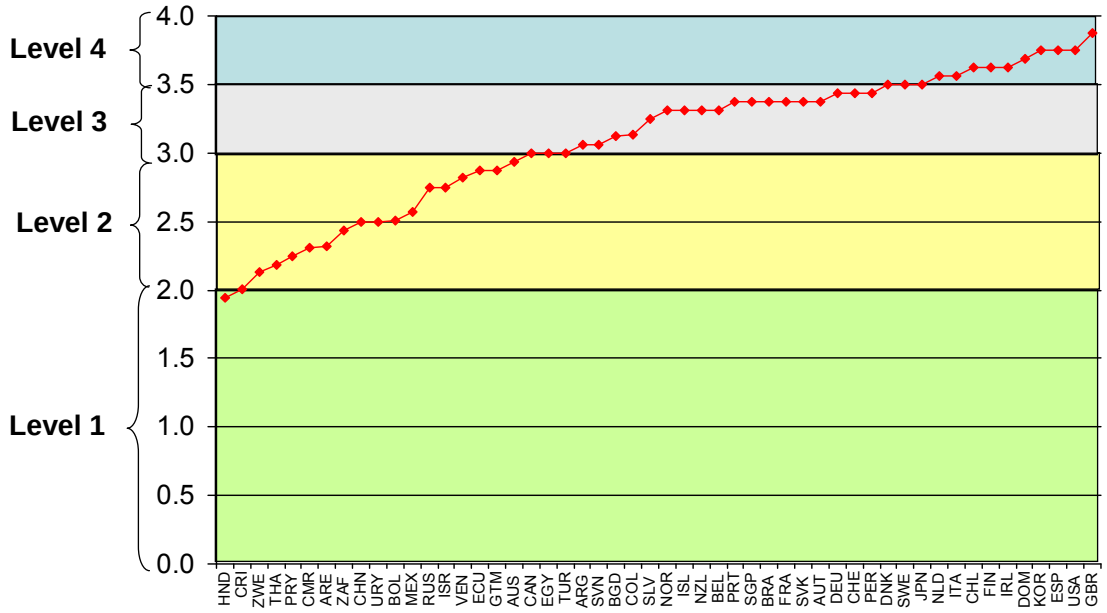
Figure 15. Country distribution according to policy

Policy Index	Stage I - Least Competitive	Stage II - Early Competition	Stage III - Managed Competition	Stage IV - Competitive / Strategic Planning
Country distribution (total=53)	1	19	21	12
Examples	Honduras	Costa Rica, Zimbabwe, Thailand, Paraguay, Cameroon, United Arab Emirates, South Africa, China, Uruguay, Bolivia, Mexico, Russia, Israel, Venezuela, Ecuador, Guatemala, Australia, Canada, Egypt	Turkey, Argentina, Slovenia, Bangladesh, Colombia, El Salvador, Estonia, Norway, Iceland, New Zealand, Belgium, Portugal, Singapore, Brazil, France, Slovak Republic, Austria, Germany, Switzerland, Peru and Denmark	Sweden, Japan, Netherlands, Italy, Chile, Finland, Ireland, Dominican Rep., Korea (Rep.), Spain, United States and the United Kingdom
Comments	● State-owned wireline monopoly ● Prohibition of VOIP ● Lack of transparency	● No clear definition of USO ● Early privatization stages	● The State still has a minority participation in the wireline incumbent ● Few countries keep some ownership restrictions for operators that managed spectrum and wireline operators	● The incumbent is fully privatized ● All industry sectors are liberalized ● There is regulatory independence and transparency There is a sector level government strategic plan

Note on intuitive country misclassifications: Australia and Canada maintain strict restrictions on foreign investment in telecommunications; The Israeli government has only recently sold a remaining participation in the wireline carrier, market structure is fairly consolidated, and there is no regulatory authority; in France, the government still holds more than 13% shares of the telecommunications carrier and only recently started developing a national plan; Denmark has only partial competition in mobile. On the other side, Spain and Dominican Republic are considered in Stage IV given their aggressive liberalization agendas and national broadband plans.

The distribution indicates that only one out of 53 countries is in Stage I confirming the assessment that the wave of sector liberalization has, to a large degree, swept the whole world. At the same time, most countries are located within Stages II and III with few of them attaining Stage IV in terms of liberalized sector combined with a comprehensive ICT National Sector Strategic Plan (see figure 16).

Figure 16. Country Distribution according to the Policy Index



5. Assessing the Relationship between Policy and Sector Performance:

Having defined both ICT sector performance and policy indices, we assessed whether there is a causal relationship between both factors. The same way we have proven in Section 4, that policy variables have had a positive impact on the historical development of the ICT sector in countries such as Korea, Japan, China, and Estonia, as well as a temporary negative impact in countries such as India and Bangladesh, we are now attempting to validate this hypothesis in the aggregate.

A regression for 2008 indices, which controls for the level of economic development, yields the following results:

Source	SS	df	MS
Model	13.364543	2	6.682272
Residual	4.4388356	49	0.905885
Total	17.803379	51	0.349086

Number of obs	=	52
F(2,49)	=	73.77
Prob > F	=	0.0000
R-squared	=	0.7507
Adj R-squared	=	0.7405
Root MSE	=	0.30098

Performance_Index	Coef.	Std. Err.	t	P > | t |	[95% Conf.	Interval]
Regulatory_Index	0.2560787	0.1009838	2.54	0.014	0.531442	0.4590133
GDP_PPP._Capita	0.0002770	3.41E-06	8.14	0.000	0.000021	0.0003460
_cons	1.1657720	0.2766412	4.21	0.000	0.609840	1.7217030

According to the linear regression, at a significance level of 5%, the positive relationship between the performance and the policy indices cannot be rejected.

While the results confirm the existence of an alignment between the introduction of competition with a later stage where the government defines a national plan and the performance of the ICT sector, we believe that countries tend to follow diverging policy paths. To understand these paths, we use plotted the historical evolution of the ICT sector performance and policy indices for selected countries (see figure 17).

Figure 17. Policy Stages and ICT Performance Levels (1980-2008)

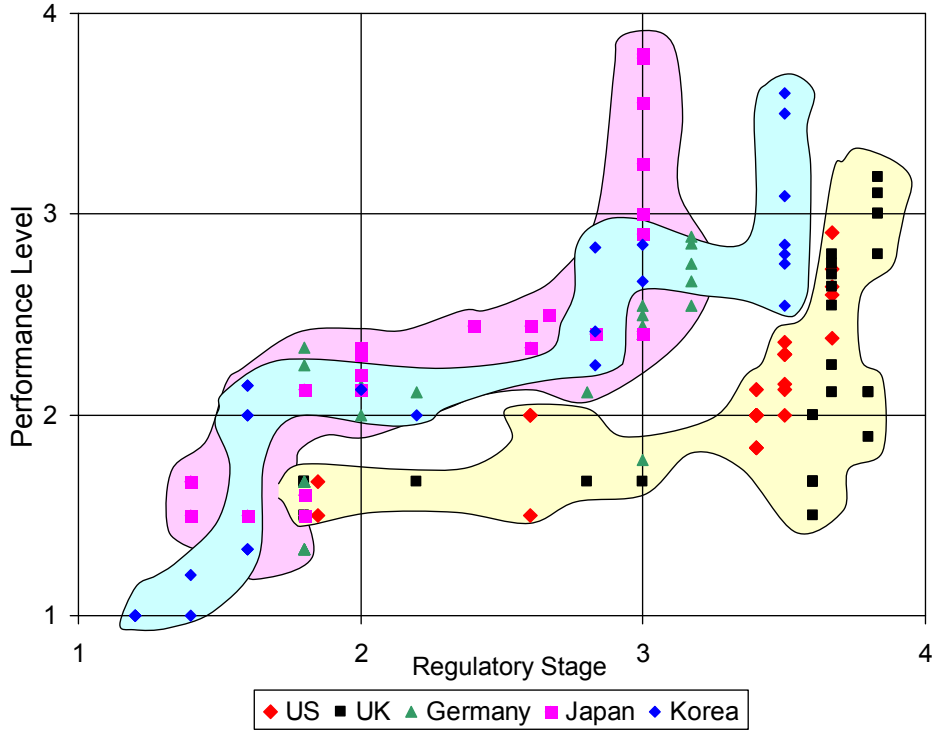


Figure 17 indicates that policy paths followed by different countries over the past three decades differ widely. There appears to be three different paths by which countries transition from low to high ICT performance by introducing changes in the policy and regulatory framework:

- **The Anglo-Saxon path:** The U.S. and the U.K. had to extensively liberalize their telecom sector before improvements in sector performance materialize. The U.S. and the U.K. pursued an early market opening, beginning in 1984 and culminating in the 1990s with almost full liberalization. However, rapid liberalization did not immediately translate into leaps in sector performance for either country. This may have to do with other factors correlated with performance, e.g. the slow economic growth during that period. It may also indicate that the regulatory framework was in some ways ahead of its time. Technology that would have allowed new entrants to develop physical or virtual alternative networks was not readily available at the time. Consumers, having been used to monopolistic prices and moderate service levels for so long, were initially slow to take advantage of the new choices offered by competitive players. Entrepreneurs and financiers needed some time to spot and evaluate the new opportunities that liberalization offered.
- **The gradual liberalization path: In** contrast, Germany and Japan followed a path of late liberalization and privatization. Both remained essentially Level 1 countries in terms of their policy index until the mid-1990s. For both, the incumbent monopoly provider of telecommunications services was largely protected from competition in core services and in turn was required to maintain high investments and appropriate staffing levels to provide the country with advanced infrastructure and services. This policy worked remarkably well over many years when technological change and customer expectations were relatively moderate, and both countries showed rapid improvement in performance levels until about the early 90s. As noted earlier, Japan overtook the US to achieve the highest performance level among leading industrialized nations. Since the mid-1990s, however, Japan and Germany have entered a phase of rapid liberalization. Regulatory focus in both countries has shifted from protection of the incumbent to creation of a broad base of competitive players. While the examples of Japan and Germany show that countries can reach high levels of sector performance without complete deregulation -notably through high capital investments in network infrastructure - it appears that the only feasible path to Level 4 performance is rapid liberalization combined with sector level planning
- **The developing path:** Korea, a country that initially had fewer resources than the other industrialized nations, had to gradually liberalize the telecom sector, in order to achieve step-by-step an improvement in performance. The Korean path represents an alternative path to the other two models in the sense that a move on the policy index is followed by an improvement in performance.

To sum up, while the two variables--policy and performance--are intricately linked, there appear to be alternative development paths to achieving high levels of sector performance. Governments can follow early, rapid or late/restrained liberalization and both philosophies can lead to good performance. There are however, two important sets of preconditions for this transformation: in a regulated environment, the incumbent needs to be reasonably efficient and the taxpayer and/or user should be prepared to should significant capital outlays. In a liberalized environment, efficient capital and labor markets must exist that allocate resources

to the most promising ventures. Alternatively, the government should provide some high-level guidance with regards to the industry developmental path.

6. Impact of Policy Framework on Level of Investment:

There is a consensus within the industry that, given the current trends in adoption and usage of bandwidth intensive applications, ultra-broadband platforms, capable of handling download speeds beyond 50 Mbps, need to be deployed. Many developed nations are witnessing the roll-out of either fiber to the home (for telecommunications carriers) or DOCSIS 3.0 (for cable TV players) to achieve these performance levels. Is the policy variable an important factor in explaining which countries are at the forefront of this trend? We hypothesize that this is the case and that platform-based competition policies appear to be the right model to promote investment in fiber to the home. To test this hypothesis, a model was specified[21] where fiber optics in the local loop was a function of pricing as a measure of competitive intensity, local loop unbundling as a regulatory obligation, and a set of control of variables, such as GDP per capita and population density:

$$FTTH_{it} = g\,(P_{it}, LLU_{it}, GDP_{it}, DEN_{it})$$

Where:

F: represents FTTH as a percentage of total broadband accesses,
P: advertised average retail price per Mb,
LLU: dummy variable depicting whether local loop unbundling has been enacted as a policy to facilitate entry of new broadband operators by obliging the incumbent to open up its network and offer access at regulated price,
GDP: GDP per capita, and
DEN: population density.

We hypothesized that:

(i) The lower the retail price, the more competitive intensity, and therefore, the less incentive to invest in new access technologies, in particular fiber, since the rate of return of capital would be lower as ARPU (average revenue per user) would decrease.
(ii) A regulatory obligation to provide access of the network at a regulated price represents a disincentive for the incumbent to invest in new access technologies since it would require for the incumbent to share its newly-acquired advantage with the new entrants, thereby reducing its capacity to differentiate product.

[21] The model was specified for an unbalanced panel of 32 countries between 2005 and 2008, which allowed estimating it using pooled data. The main data source was the OECD broadband portal, supplying information of Fiber to the Home (FTTH) connections as a percentage of the total broadband connections since 2006; it was complemented with IDATE data. The source of Local Loop Unbundling data was the OECD and the ITU regulatory database available for the years 2005 to 2009. The source of GDP information was the IMF (2005-2008) while the source for population density was the OECD and WDI.

(iii) Carriers will invest in markets with higher demand profile and higher population density as a way to positively affect the rate of return because of size of primary demand and potential economies of scale.

The model was specified for an unbalanced panel of 32 countries between 2005 and 2008, which allowed estimating it using pooled data. The main data source was the OECD broadband portal, supplying information of Fiber to the Home (FTTH) connections as a percentage of the total broadband connections since 2006; it was complemented with IDATE data. The source of Local Loop Unbundling data was the OECD and the ITU regulatory database available for the years 2005 to 2009. The source of GDP information was the IMF (2005-2008) while the source for population density was the OECD and WDI.

The characteristics of the data panel were as follows:

Figure 18. Data sets for NGN investment model

Factor	Name	Description	Source	Mean	Std	Min	Max	ObsN	Obs
• Investment	FTTHit	• FTTH as a percentage of total broadband accesses	OECD, IDATE	1.08	2.61	0	13.81	91	31
• Market structure	Pit	• Advertised average price per Mb	OECD	29556.27	20.73	29.37	0.24	121	31
• Policies and regulation	LLUit	• Dummy variable depicting whether such a policy is in place	OECD, ITU	0.78333	0.4137	0	1	120	31
• Socio-Demographic	GDPit	• GDP per captia (US$ PPP)	IMF	29556.27	12955.2	3614.1	81221.64	128	31
	DENit	• Population density	OECD and WDI	129.42	120.63	2.59	488.17	121	31

Model results indicate that fiber deployment is negatively related to local loop unbundling regulations and the level of competitive intensity.

Figure 19. Panel Data Estimation - Fixed Effects

Source	SS	df	MS
Model	188.413476	4	47.103369
Residual	423.599406	83	5.1036073
Total	612.012882	87	7.03463083

Number of obs	= 88
F(4, 83)	= 9.23
Prob > F	= 0.0000
R-squared	= 0.3079
Adj R-squared	= 0.2745
Root MSE	= 2.2591

ftth	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
llu	-1.468644	.6708716	-2.19	0.031	-2.802981	-.1343077
gdp	-3.49e-06	.0000205	-0.17	0.865	-.0000442	.0000373
densidad	.0087334	.0020984	4.16	0.000	.0045597	.0129071
price	-.037539	.0152102	-2.47	0.016	-.0677914	-.0072865
_cons	1.823524	1.034692	1.76	0.082	-.2344377	3.881485

According to the model results, unbundling local loops is negatively related, at a significant level, to the deployment of fiber to the home. Consistent with all the literature previously reviewed, platform-based competition acts as a stimulus of investment in forward looking technologies. Furthermore, as expected, population density is positively linked to fiber deployment. Higher density raises the rate of return of capital investment because it allows a larger number of customers being connected to the newly deployed network. Finally, the pricing of broadband services is negatively related to fiber deployment. If pricing is an indicator of competitive intensity, the lower retail prices of broadband, the less incentive there is to deploy FTTH because, at lower ARPUs, the NPV of the fiber project diminishes.

7. Impact of Policy Framework on Degree of Innovation:

To provide additional support to the assessment of the policy impact on the ICT sector level of innovation, we have built a model explaining the rate of adoption of mobile internet. We have chosen mobile internet because it represents the next frontier of product innovation in the ICT sector, comprising several supporting platforms from wireless broadband (3G, HSPA, LTE) to innovative devices (Blackberry, iPhones), to the range of applications stores offered by providers like Apple, Nokia, and Microsoft.

For this purpose, we defined a model where the rate of adoption of mobile internet (measured by the percent of mobile industry revenues derived from these services) is a function of market structure (in other words, the degree of market consolidation and competitive intensity), a range of regulatory policies (from institutional variables such as the degree of regulatory independence to regulations such as number portability) and a set of control of variables, such as GDP per capita, size of target market and level of urbanization[22]:

$$REVDATA_{it} = g\,(M_{it}, P_{it}, S_{it})$$

Where:

REVDATA: represents the percentage of revenues derived from mobile broadband for a given country
M includes a market structure variable:
HH: Herfindahl-Hirschman Index for the mobile industry in a given country
P comprises four policy and regulatory variables:

[22] The model was specified for a panel of 42 countries between 2002 and 2008. The source of the dependent variable (percent of revenues derived from mobile data), used as a proxy of level of innovation in a given market, is the Merrill Lynch Mobile Matrix. The Herfindahl-Hirschman Index was calculated from market share contained in the same data base. The main source for the regulatory data was the ITU regulatory database. Regarding the control variables, the source of GDP per capita is the IMF, the Index of Economic Freedom is derived from the annual report provided by the Heritage Foundation, and the urban population index and the population between 15 and 64 have been gathered from the WDI databases.

IDMC: indicator of regulatory independence in a given country
MNP: dummy variable indicating the existence of mobile number portability
NMPY: years since mobile number portability has been enacted
OWNCAP: indicator of foreign ownership restrictions in wireless service providers

S comprises four socio-demographic variables:

GDP: GDP per capita (measured in US$ PPP)
EF: index of economic freedom
URBAN: urbanization index
POP: percentage population between 15 and 64 years of age

Accordingly, the following hypotheses were formulated:

(i) In competitive markets, consolidation increases incentives for innovation. According to the research literature in industries other than telecommunications[23], high levels of competition could promote a greater focus on measures aimed at yielding operating efficiencies and reducing costs. On the other hand, lower levels of competition as a result of strategic alliances or consolidations could reduce the risk of innovation initiatives.

(ii) Certain sector and non-sector specific policies and regulations represent an incentive to innovate:
- Policies oriented toward reducing customer switching costs (e.g. number portability) will stimulate innovation in order to preserve loyalty;
- A regulator perceived as not being sufficiently independent from the government will reduce the incentive to innovate because a successful differentiation strategy could lead to asymmetric pressures (e.g. renegotiate licenses, artificially set price caps);
- Sector restrictions to FDI (trade, corruption control, etc.) could result in limited willingness to innovate

(iii) The policy variables notwithstanding, companies will invest in markets with higher demand profile; this is therefore, a control variable

The model was specified for a panel of 42 countries between 2002 and 2008. The source of the dependent variable (percent of revenues derived from mobile data), used as a proxy of level of innovation in a given market, is the Merrill Lynch Mobile Matrix. The Herfindahl-Hirschman Index was calculated from market share contained in the same data base. The main source for the regulatory data was the ITU regulatory database. Regarding the control variables, the source of GDP per capita is the IMF, the Index of Economic Freedom is derived from the annual

[23] Nicholls-Nixon & Woo, 2003; Rothaermel & Deeds, 2004; Shan, Walker, & Kogut, 1994

report provided by the Heritage Foundation, and the urban population index and the population between 15 and 64 have been gathered from the WDI databases. The whole panel contained 272 observations with the following characteristics:

Figure 20. Date sets for mobile internet model

Factor	Name	Description	Source	Mean	Std	Min	Max	ObsN	Obs
Innovation	REVBAMit	• Percentage of revenues derived from mobile broadband	Merrill Lynch (2005-2009)	0.14	0.078	0.0125	0.4653	293	45
Market structure	HHIit	• HERFINDAHL-HIRSCHMAN INDEX	Calculated based on Merrill Lynch	3904.289	1858.122	1656	15761	356	52
Policies And regulation	IDMCit	• Regulatory independence	Calculated based on ITU	2.12	1.14	0	3	371	53
	MNPit	• Mobile number portability	ITU	0.464280	0.4994	0	1	364	52
	NMPYit	• MNP years enacted	ITU	1.5247	2.3895	0	11	364	52
	OWNCAPit	• Foreign ownership of mobile operator	ITU	0.9650	0.1295	0.4	1	371	53
Socio Demographic	GDPit	• GDP per capita (US$ PPP)	IMF	19,878.4	13618.4	925.61	53450.7	368	53
	EFIit	• Index of Economic Freedom	Heritage Foundation	65.52	10.57699	39.9	90	364	53
	URBAN	• Urbanization Index	World Bank	69.72106	18.043	24.44	100	357	51
	POPit	• Percentage population between 15 and 64	World Bank	66.1793	3.5921	53.47	74.89	357	51

To test the first hypothesis a piecewise specification is introduced for the Herfindahl-Hirschman Index. LHHI1 indicates markets where the HHI is under 0.3600 and LHHI2 indicates markets where the concentration level is equal or greater than 0.3600. By relying on logarithmic functions in order to render this model linear, the following model was specified:

$$LREVDATA_{it} = \beta_0 + \beta_1 LHHI1_{it} + \beta_2 LHHI2_{it} + \beta_3 LMNP_{it} + \beta_4 NMPY_{it} + \beta_5 LGDP_{it} + \beta_6 LEFI_{it} + \beta_7 LURBAN_{it} + \beta_8 LPOP_{it} + \beta_9 IDMC_{it}$$

Figure 21. Panel Data Estimation - Fixed Effects

Revdatait	Coef	Std.Err	P>|t|	
LHHI1it	0.4957	0.2999	0.0990	*
LHHI2it	1.4812	0.4821	0.0020	***
MNPit	0.1216	0.0675	0.0730	*
NMPYit	0.0575	0.0170	0.0010	**
LGDPit	1.4016	0.3206	0.0000	***
LEDIit	-0.4188	0.6240	0.5030	
LUrbanit	3.3711	1.4740	0.0230	**
LPOPit	7.1762	3.6486	0.0500	*
IDMCit	0.0510	0.0407	0.2130	
Cons	-58.8322	14.5801	0.0000	***

Sample	282	
Periods	7	
Observations	43	
R^2	0.6274	
F-test	23.2	(0.0000)
Heterocedasti	110000	(0.0000)
Wald X^2 (43)		

* 10% significance level
** 5% significance level
*** 1% significance level

The model results led to several conclusions:

- Market concentration is directly linked to innovation**:** consolidation provides operators with a higher certainty of potential returns to invest in wireless data development[24].
- Mobile number portability and years of policy enactment is directly linked to innovation: portability does not necessary lead to churn but the threat of churn provides, as was hypothesized, an incentive for operators to innovate in products in order to build loyalty

[24] To test the existence of an inverted-U relationship between innovation and market concentration, a model with a quadratic HHI term was also estimated (e.g. B_1 HHI + B2 HHI^2). According to the theory, B_1 should be positive, while B_2 negative to prove the existence of a quadratic relationship and that the optimum point of the quadratic shape is a maximum. The results obtained showed that the signs of the coefficients behave accordingly to the theory but were not significant. This situation could result from the lack of information on product innovation in countries with HHI greater than 0.6.

- Regulatory independence and innovation are not significantly linked: in the mobile market, the market is driving innovation and therefore, the degree of regulatory independence is not an important variable in explaining new product development
- All socio-demographic variables are directly and significantly linked to innovation: market potential is a critical variable driving innovation

To conclude, beyond the expected market attractiveness, innovation in wireless internet appears to be driven by two factors from the public policy tool-box. First, a moderate amount of competition is required to stimulate innovation. Policy initiatives aimed at fragmenting the structure of supply beyond an optimal level will have a negative impact on the degree with which operators will innovate in products and services. Aggressive spectrum allocation aimed at multiplying the number of players, small spectrum caps preventing market concentration and MVNO licensing might have a negative impact on innovation insofar that higher than optimal competition acts as a deterrent from product differentiation.

Second, the threat of growing churn embodied in number portability which lowers customer switching costs acts as an incentive to innovate in order to enhance loyalty. Third, in a market that has been significantly liberalized around the world, regulatory independence appears to play no role in fostering innovation. The optimal level for deployment of wireless broadband is driven by a certain amount of market concentration and a moderate level of competitive intensity. The higher market concentration is, the larger the incentive to innovate. This could be associated to both the certainty of obtaining a return on the introduction of a new product (wireless data products) and the ability to capture a larger share of demand.

The Mexican experience confirms these findings from a negative standpoint. A very gradual market liberalization and hesitancy in opening markets has significant negative effects in sector performance. The privatization of Telmex had benefits in terms of accelerating the deployment of fixed line telephony, in particular reaching high penetration at lower levels of the socio-demographic pyramid. However, the incumbent was capable of establishing a significant number of barriers to entry in local telephony through either sector-specific (interconnection rates, license restrictions) or non-sector specific (limits to foreign ownership). These were reinforced by a legal system that guaranteed the capability of delaying any government attempts to liberalize the market. These barriers had a negative effect on wireline service deployment. The proof of the important positive contribution of competition toward sector performance lays both in the broadband and wireless sectors. The activity of cable TV operators in the former and wireless competitors in the latter resulted in a more dynamic market, leading to higher static and dynamic efficiencies[25].

[25] Recent regulatory moves taken by Mexican authorities confirm the will to move sector dynamics to becoming more competitive. The SCT launched an auction for three concession licenses to operate dark fiber belonging to the state electricity company. This auction is aimed at boosting competition against Telmex wireline business. In addition, the antitrust authority has concluded that Telmex has a dominant position in call termination on fixed lines, while AMX has a dominant position in the wireless market. It remains to see whether these moves will result in stimulating competition.

8. Conclusion:

The purpose of this paper was to determine quantitatively whether the policy and regulatory variables have an impact on the performance of the ICT sector. In the introduction we anticipated that, given data limitations as well as the complexity of some of the relationships, it might not be possible to fully ascertain the impact of policy on sector performance. This is the reason the conclusions to be derived from this analysis need to be complemented with qualitative case studies of specific situations which could serve to either validate the quantitative findings, or complement our perspective with the rich combination of analytical techniques. The case studies have been selected with the help of the quantitative analysis and will be the subject of the next paper.

The recognition of limitations of statistical analysis notwithstanding, it was possible to identify several effects confirming the degree of impact of policy on sector performance. This was achieved through implementing three convergent approaches:

- Identification of policy initiatives allowing to explain the performance of selected countries over a relatively long time-span,
- Multivariate regression analysis of telecom sector performance against a policy index, and
- Econometric analysis of the factors driving investment in Next Generation Networks and the adoption of wireless data products.

The first analysis successfully identified policy and regulatory variables that explain the successful improvement in sector performance of countries as diverse as Korea, Sweden, China, and Estonia as well as the temporary shortfalls for countries like India and Bangladesh.

The second analysis showed that, when controlling for economic development, policy and regulation (as measured by the policy index developed in this paper) are significantly powerful in explaining sector performance (when measured by the performance index).

The third analysis concluded that specific policies play an important role in explaining investment and innovation. For example, unbundling local loops appear to have a detrimental effect on NGN investment, while number portability and degree of wireless market concentration can explain level of innovation in wireless data products.

These findings confirm the results of our literature review. However, as expected, the analysis also highlighted the need to develop case studies that would enable the understanding of qualitative variables (for example, the impact of ICT sector planning on performance) as well as identifying exceptions to the quantitative analysis.

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Section IV: Policy and Development of ICT

Part C: Appendix: Case Studies in ICT Policy

Part C.1: Full Liberalization Yielding a Step Function Improvement in Sector Performance: Brazil

By Raul L. Katz (Columbia University)

1. Introduction:

Brazil, the world's fifth-largest country and the eighth economy with a population of 156 million people, had in 1997 only eight phone lines per 100 people, half as many per capita as neighboring Argentina and a fraction of the 62 lines per hundred residents in the U.S. More than 750,000 people had placed orders for cell phones just in the city of Sao Paulo, capital of the industrial heartland, but had yet to receive service. In July 1996, when the state-run telephone company announced that it was making 55,000 wireless lines available to customers, the calls flooded the company's switchboard and the phone circuits through much of the city were paralyzed for days. Overwhelmed by the huge increase in telephone traffic, company

officials pleaded with cellular seekers to order by mail. There were 1.4 million applicants when the phone company stopped counting.

Brazilians were increasingly using cell phones as substitutes for the underdeveloped state-controlled wireline telephone network, Telebras, which had a backlog of 10 million customers seeking lines. During the 1960s, Brazil's military government had built a topflight land-based phone network closely patterned after the U.S. Bell system. By the early 1980s, however, the Latin American debt crisis had left Brazil's government bereft of the capital needed to maintain the system. Telebras' budget constraints kept cellular phones from being introduced in Brazil until 1990 (compared to 1985 in the U.S.), but they proved an almost immediate sensation. The first lines cost $20,000 each –and still demand far outstripped supply. Unable to obtain wireless service from local companies, Brazilians in major population centers like Rio de Janeiro and Sao Paulo began purchasing cellular lines from carriers in the provinces[26]. In addition, an informal secondary market for cell phone lines in Sao Paulo sprang up in response to the shortage of new lines. In the gray market, a wireless line sold in 1997 for about $2,500, compared to $ 3,500 for a fixed line.

It was in this context that Brazil started reforming its telecommunications sector, which underwent a dramatic improvement in the last 10 years as a result of a concerted effort of the successive governments to privatize the state-owned monopoly and open the industry to competition. Changes in sector performance indicate a big improvements in all areas of sector performance (see figure 1).

Figure 1. Brazil: Changes in Sector Performance

		1980	1990	2000	2010
Service penetration (per population)	Fixed Telephony	4.07%	6.3%	17.7% (11% in 1998)	21.2%
	Wireless		0 %	13.31 % (1.5 in 1996)	96.5%
	Broadband			0.005%	6.8%

[26] Soon the owners of these transplanted lines, known as "turistas", accounted for about 20% of all the cellular traffic from the two largest Brazilian cities, even though these subscribers had to pay long-distance rates for local calls. These "turistas" strained local cellular networks, which were in a sorry state to begin with. Telerj, the state-run phone company from Rio de Janeiro, attempted to reduce the congestion by installing 200 new cellular antennas. Unfortunately, the installers inadvertently knocked out dozens of the existing antennas in the process.

Service quality	Faults per 100 (main) lines per year	5.7	4.7	3.14	1.3

Source: Business Monitor International (1Q10), ITU

As figure 1 indicates, the most dramatic changes in the Brazilian sector performance occurred between 1998 and 2010, and are consequently directly linked to the privatization of the Telebras system (1998), the opening of the wireless industry to competition (1996), and the liberalization of the wireline and broadband markets (2002).

2. The reform of the telecommunications sector:

Telecommunications sector reform in Brazil was launched in 1991, although as was the case in many other Latin-American countries, it initially failed due to political instability during the impeachment and later resignation (1992) of the president and main proponent of the privatization agenda, Fernando Collor de Mello. This initial failure provided time and experience for policy makers to develop the necessary regulatory and institutional framework before the privatization and liberalization occurred. The second attempt to reform the sector started in 1996 when the Brazilian government decided to open the Brazilian wireless sector to private and foreign investors in 1977.

For Brazil, the auction of licenses was more than a mere infrastructure upgrade. It would be the nation's signal to foreign investors that the country was open for business since its economy stabilized and started growing in 1993, after two decades of hyperinflation. The Real Plan had quelled inflation and primed consumption by pegging the local currency to the dollar. The program had produced undeniable results: monthly inflation had fallen to less than 1% from 50%; real wages had increased by 30%; more than five million Brazilians had been elevated from extreme poverty, and a consumer culture had flourished overnight.

The process of telecommunications sector reform, started in 1996, can be divided into four phases: the liberalization of the mobile sector; the privatization of the Telebras system; the development of duopolistic competition and, finally, the liberalization of the fixed-line market (see figure 2).

Figure 2. Brazil: Chronology of Telecommunications Sector Reform

- First Phase: Liberalization of the mobile sector (1996-2001)
  - Band B License auction (1997)
  - Band D License auction (2001)
  - Band E License auction (2001)
- Second Phase: Privatization of Telebras (1998)
- Third Phase: Opening of the wireline market to duopoly competition (1998-2002)
- Fourth Phase: Liberalization of the wireline market (2002-today)

Within seven years, Brazil conducted one of the most sweeping reforms of the telecommunications sector in the emerging economies. Sector reform was launched in 1995 when the Brazilian Congress passed Constitutional Amendment No. 8, ending the state monopoly of telecommunications services. However, congress established that, before implementing the amendment, a law defining the role of the state in the sector and the new general principles that would govern the sector should be enacted.

Foreseeing that a general law would slow down the reform process, the Minister of Communications immediately submitted a law to open the cellular telephone service sector to competition by selling licenses to operate mobile cellular service in Band B of the frequency spectrum. For this purpose, the country was divided in ten regions that were classified in two groups: more-developed and less-developed areas. Each potential buyer of the concession could buy only one license in each group. Further, the invitation to tender demanded the presence of a strategic investor in each of the consortia bidding for concessions, with proven experience in the management of cellular telephone companies and limited the participation of non-Brazilian capital to 49 % of the voting stock.

The auction elicited a high level of interest on the part of foreign investors:

- AT&T partnered with Organizacoes Globo SA, a media empire controlling over 50% of the broadcasting TV and print media markets, and Bradesco, a retail bank;
- GTE (now part of Verizon) was partnering with NEC, the Japanese cell phone manufacturer;
- BellSouth (now part of ATT) partnered with Banco Safra S.A., one of the country's largest banks, Splice, a telecommunications equipment provider and O Estado de Sao Paulo, the second largest media group;
- AirTouch (now part of Verizon) entered a consortium that included Odebrecht S.A., a $4 billion Brazilian construction company
- Telia, the Swedish carrier, Bell Canada, and SBC (now part of ATT) were also expected to bid

The process was ultimately a success raising a substantial amount of cash for the Brazilian treasury and launching a process of market liberalization. The Band B auction was followed by successive auctions of other frequency bands after 2001 (Band D and Band E).

In parallel with auctioning spectrum licenses, the Communications Ministry worked on the preparation of the Telebras companies for privatization. This process had two main goals: first, correct the distortions in the tariffs structure by increasing local tariffs and reducing long distance tariffs, especially international rates, and second, eliminate the system of sharing of long distance revenues between Embratel, the only national long distance provider, and local

exchange companies[27]. In 1997, Congress approved the General Telecommunications Law. The main points in the new law covered the general principle governing telecoms services, the creation of the regulatory agency Agência Nacional de Telecomunicações (Anatel), the definition of telecommunications services[28], and the restructuring and privatization of the Telebras system.

It is important to note here that, in contrast to the Mexican experience, the privatization of Telebras only took place once the company was restructured and the regulatory framework that would govern the sector was defined. In addition, rather than privatizing the company as a single entity, Telebras was divided in nine cellular companies, three wireline regional carriers, and a national long-distance company. The companies to be privatized were divided in three groups[29], the first including the three wireline operators and Embratel (the long distance provider), the second including the mobile companies serving in more economically-favored areas, and the third comprising mobile companies serving less-economically developed areas.

Following the same methodology implemented in the liberalization of the cellular market, each participant could acquire only one company in each sector, but there were no restrictions on participation of non-Brazilian capital. Each privatized wireline company would also face only one competitor owning a license in the same geographical area until the end of 2001, when the government promised to eliminate entry constraints. The incumbents could enter other areas after 2002 if they had reached universal service targets; otherwise, they could only expand geographically after 2004.

After the privatization of the incumbent, the Brazilian government did not give a period of exclusivity (monopoly) to the new controlling shareholders. The principal criterion in awarding the authorizations to operate "mirror companies" [30]was technical: the bidder offering higher penetration of individual customer service and of public telephones than the minimum levels specified in the invitation to bid would have an advantage in the auction, since the technical criteria carried a weight of 70 per cent in the final score, compared to a 30 per cent weight for the price criterion. The main rights conferred to the mirror companies, not shared by the incumbents, were the permission to use wireless local loop technology, to acquire cable TV companies and respective networks.

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[27] Patterned after the Bell system, the Telebras company was structured around a long distance company, Embratel, and a series of local exchange companies.

[28] The establishment of a definition of what should be considered as telecommunication service and the classification of telecommunications services

[29] Group 1: wireline and long distance (Telesp, Tele Norte- Leste, Tele Centro-Sul and Embratel);
Group 2: cellular telephony in the more economically favored areas (Telesp Celular, Tele Sudeste Celular, Tele Sul Celular and Telemig Celular); and Group 3: cellular telephony in the less economically favored areas (Tele Leste Celular, Tele Nordeste Celular, Tele Norte Celular and Tele Centro-Oeste Celular).

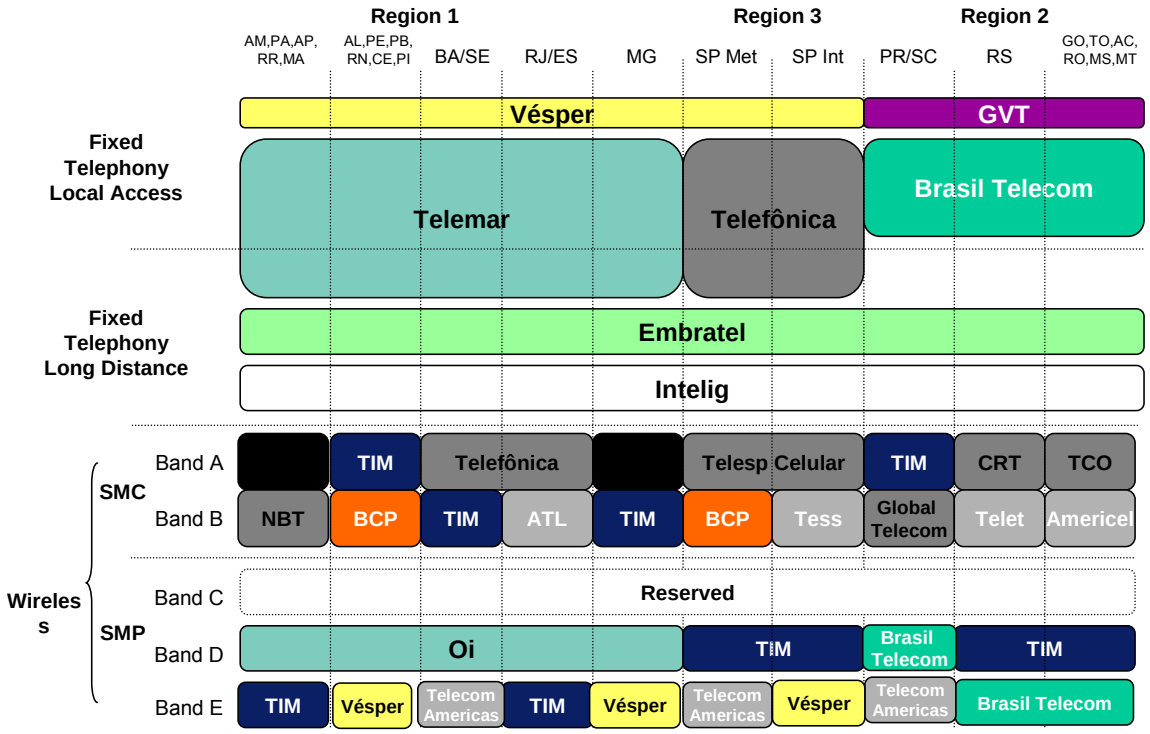
30 The term "mirror companies" comes from the fact that there had to be only one new entrant for each incumbent in each region. Several regulatory rules for the mirror-companies were less stringent than for the incumbent companies, given the need to outweigh first-mover advantage. The main duties of the incumbents, not imposed on the entrants, were the fulfillment of universal service targets, the compliance with a price-cap control; stricter fulfillment of non-interruption of the service and accounting separation.

In 2002, the incumbents Telefonica, Telemar, and Embratel met universal service targets, thus qualifying to enter other areas/services. By the end of 2003, six groups actually entered other areas.

3. Industry consolidation and the creation of a "national champion":

After the liberalization of the Fixed Line segment in 2002 and the sequential wireless auctions of bands B, D, and E, the telecommunications industry structure was highly fragmented (see figure 3).

Figure 3. Brazil: Telecommunications market structure in 2002



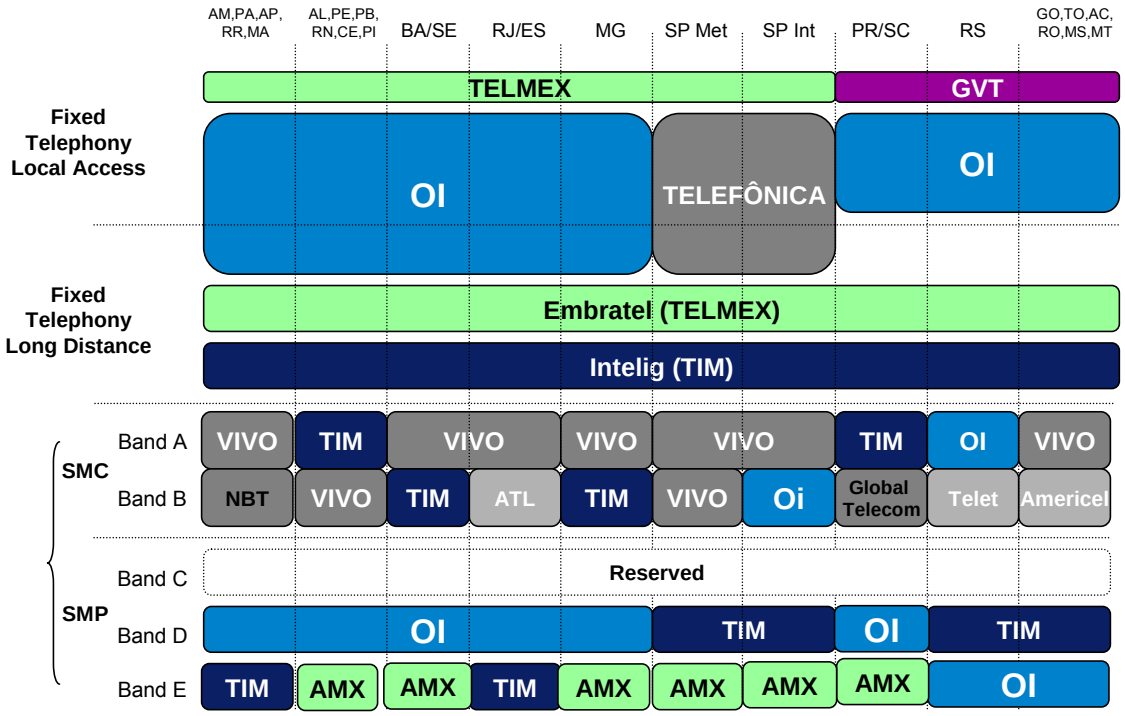
It was at this point that a process of industry consolidation began. Consolidation entailed primarily the wireless industry in which a number of the original winners of auctions that had launched service (BellSouth, Telia) sold their ownership to other players.

On the wireline side, the Brazilian government engineered over the past two years the creation of a national champion. Concerned about the whole sector falling into the hands of foreign owners, the government promoted the merger of two of the three major regional carriers, Brasil Telecom and Oi. This required the modification of the original law. In October 2008, the Brazilian regulator Anatel agreed to approve changes to regulations that ended a prohibition on the controlling shareholders of Brazilian telephone companies from owning a phone carrier in

another region of the country[31]. Telemar would now be able to create a telephone company serving two-thirds of Brazil's fixed lines and almost a fifth of its mobile phones. Under the proposed acquisition, Brazil's state-owned development bank BNDES and three pension funds of state-controlled companies would own 49.8% of the new carrier.

The resulting consolidation process led to the creation of four nationwide operators (see figure 4)

Figure 4. Brazil: Telecommunications market structure in 2009



The resulting market share of the four groups was as follows (see Table 5):

Table 5. Brazil: Market Share of Principal Groups (3Q09)

Companies	Revenues	Fixed	Cellular	Broadband	Pay-TV
Telefonica/Vivo	29.01%	27.20%	29.40%	23.20%	7.20%
Oi	28.86%	51.60%	21.00%	37.30%	0.90%
Claro/Embratel/Net	23.04%	15.20%	25.50%	25.10%	51.40%
TIM	11.34%		23.80%		
Others	7.74%	5.90%	0.30%	14.40%	40.60%

Source: Teleco

[31] As mentioned above, the Brazilian Telecommunications Law provided regional concessions to telecommunications carriers preventing them from acquiring each other

The group comprised of Telefonica and Portugal Telecom is the biggest player in terms of revenues, controlling 29 % of the market. It is composed of Telefonica's ownership of the Sao Paulo state wireline company and a Telefonica/Portugal Telecom joint venture of Vivo, a national wireless carrier. The second player in terms of revenues, Oi controls almost an equal share of the market (28.8 %) and comprises a wireline presence in two of the three regions into which the country has been divided and a national wireless presence. The company is controlled by the industrial conglomerate Andrade Gutierrez and La Fonte Group, with the BNDES and institutional investors being the largest shareholders. The third player, controlled by Grupo Carso, owns the national long distance carrier, Embratel, the national long distance carrier, a national wireless operator, and Net TV, a cable TV operator with operations in São Paulo, Rio de Janeiro, Belo Horizonte, Porto Alegre, Curitiba, Florianópolis, Manaus, Brasília and Goiânia. It controls 23 % of demand. The fourth largest player is Telecom Italia Mobile, which is limited to a national wireless presence and captures 11 % of demand.

In addition to the four largest groups, some smaller, marginal players still remain, such as the wireline carrier GVT, recently acquired by Vivendi, and Sercomtel, the fixed and mobile line provider controlled by the municipality of Londrina and Companhia Paranaense de Energia (Copel).

The resulting market concentration indicates that despite the government's attempts to stimulate competition by dividing the market in numerous regions, the industry has been gradually concentrating in a few vertically integrated players with presence in wireline, wireless and broadband. An analysis of market structure for each of the businesses shows a varying degree of competitive intensity. For example, in the wireline business, each region[32] exhibits important levels of concentration. In region I and II, Oi still holds an important market share. On the other hand, Telefonica maintains a considerable market share in the region III where it is the incumbent (see figure 6).

Figure 6. Brazil: Wireline market shares by region (2009)

COMPANY	REGION I	REGION II	REGION III
Oi	83.80%	78.50%	
Telefonica			76.50%
GVT	2.70%	10.00%	
Embratel	11.30%	8.20%	20.40%
Sercomtel		1.60%	
Others	2.20%	1.70%	3.00%

Source: Teleco, Anatel

[32] As explained above, the Telecommunications Law defined two types of operators, the ones operating under concession (incumbents) and the ones operating under authorization ("mirror companies" and new entrants) in each region.

Contrary to the situation in the wireline market, the wireless market presents a high level of competition in each region. From the market consolidation process in the wireless market, four groups have emerged (see figure 7).

Figure 7. Brazil: Wireline market shares by region (2009)

COMPANY	REGION I	REGION II	REGION III
Vivo	25.86%	31.54%	35.34%
Claro	21.19%	28.31%	30.97%
TIM	24.64%	23.89%	21.45%
Oi	27.78%	16.00%	12.03%
CTBC	0.52%	0.06%	0.16%
Sercomtel		0.19%	
Aeiou			0.05%

Source: Teleco, Anatel

4. The battle for convergence:

Technological advances have forced a reexamination of the rules and regulations governing the telecommunication sector around the world. In Brazil, efforts to modify the regulatory framework to deal with convergent technologies have been made but they have faced increasing resistance from some industry players. This process has prevented the telecommunication operators from offering content distribution services and the possibility of leveraging fixed-mobile convergence business opportunities.

In the first area, the Telecommunications Law passed in 1997 explicitly prohibited the offering of pay-tv services using telecommunications networks[33]. This prohibition was seen at the moment as an incentive for the deployment of cable infrastructure. Currently, a proposal to amend the Telecommunications Law, introduced in 2007, is being discussed in the Congress. This project, commonly known as "PL 29," would allow telecommunications operators to provide IPTV, but would establish barriers to protect the Brazilian content providers, mainly Globo[34], by establishing quotas of national programming, limits in cross-ownership between telcos and broadcasters or content producers, and caps in the amount of foreign ownership for national content providers.

[33] Telcos can only offer pay-tv services using Direct to Home satellite services, using a special frequency band (MMDS) or in association with a pay-tv provider.

[34] Globo is the most important content producer and distributor in Brazil. Its income in 2004 was around US$1.5 billion (almost one third of the total advertisement expenditures in the country) and its national audience share was 65%. All of the ten most popular television programs in Brazil in January 2005 were produced and broadcasted by Globo. The conglomerate also controls more than 75% of the market of pay-tv through its investments in cable (Net Servicios) and satellite providers (Directv).

In the second convergence battle, there have been regulatory tensions surrounding the definition of fixed and mobile services. The introduction of fixed wireless access (FWA) or Wireless Local Loop (WLL) as a substitute of traditional local telephony has resulted in a stimulus to the adoption of local telephony especially in underserved areas. It has also triggered a complication when defining the regulation of such a service. In an effort to limit competition, mobile companies requested the regulator to limit the mobility range in which companies using FWA or WLL could operate. In 2007, Anatel, following the pressure exercised by mobile companies, accepted the principle that even when new wireless local loop technologies allow a certain area of mobility for fixed telephony services, these services must abstain from mimicking mobile services core characteristics. The future of this market boundary is unclear. Mobile operators such as TIM have already started offering fixed wireless services, especially in underserved areas. In response, FWA and WLL operators could argue that they should be allowed to offer mobile services.

5. Development of a National Broadband Plan:

Broadband development in Brazil is lagging that of other Latin American countries. Brazil broadband penetration is 5.5%, compared to 7.9% in Argentina, 7.1% in Mexico and 8.9% in Chile. Even in large urban concentrations, broadband penetration reaches 9.6%, compared to 31% of Buenos Aires. This situation is quite dire when it comes to coverage of lower socio-demographic segments.

To tackle this shortfall in ICT deployment, the Brazilian government, through its Secretariat of Strategic Affairs, is in the process of developing a National Broadband Plan. The rationale for such a project is the need to significantly reduce the digital divide that so far has favored the urban upper classes. The government considers that a government sponsored plan is required to break what they consider to be a tacit collusion and cream-skimming behavior when it comes to the deployment of broadband. According to this perspective, the existing competitive dynamics in broadband have resulted in a cartel-like equilibrium, whereby the two incumbent telcos (Oi and Telefonica) do not enter their respective territories and the cable TV operator (NET) only competes through cream-skimming. As a result, effective platform-based competition exists only in 92 municipalities out of 5,500. In this context, the government is considering investing in the broadband sector through the deployment of a national backbone and potentially becoming the retailer of "last resort".

The government's objectives are to provide universal broadband service by defining four types of policies to tackle development objectives:

- For the urban higher socio-demographic segments (income classes A and B), the objective is to leverage platform-based competition in order to stimulate deployment of next-generation networks capable of delivering download speeds of up 100 Mbps. This will cover approximately 100 municipalities;

- For the higher socio-economic segments resident in isolated and rural areas, create the necessary stimuli for existing private carriers to extend service

- For the lower socio-demographic segments (income classes C, D, and E) in urban areas, the government is projecting to create the necessary policy tools to allow deployment of low-cost wireless broadband services by private carriers. This would include the elimination of taxes that tend to increase the cost of telecommunications by 40% to 50%

- For the unserved lower socio-demographic segments in rural and isolated areas, the government would consider funding the deployment of micro-telcos interconnected with the national backbone through a government-owned network that leverages the fiber optic capacity of electric and oil utilities[35].

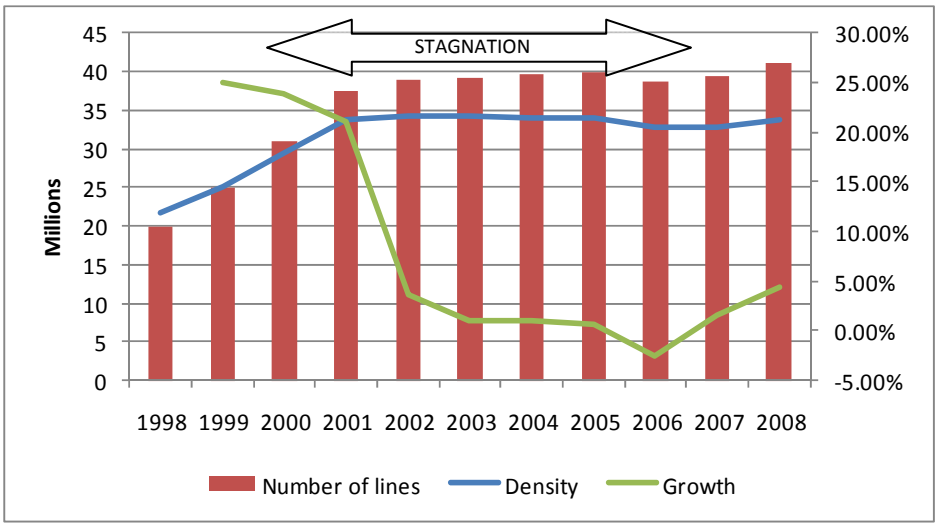
Several questions still are being defined, such as whether an enforcement of duct sharing and passive infrastructure would be enforced on the incumbent telcos, or how to negotiate a reduction of taxes with state authorities (rather than federal tax agencies).

6. Results:

6.1. Service Penetration

Between 1998 and 2002, just after the privatization process, the number of fixed lines almost doubled and penetration levels increased by almost 10% (see figure 9)

Figure 9: Brazil: Evolution of Fixed Lines Post Privatization

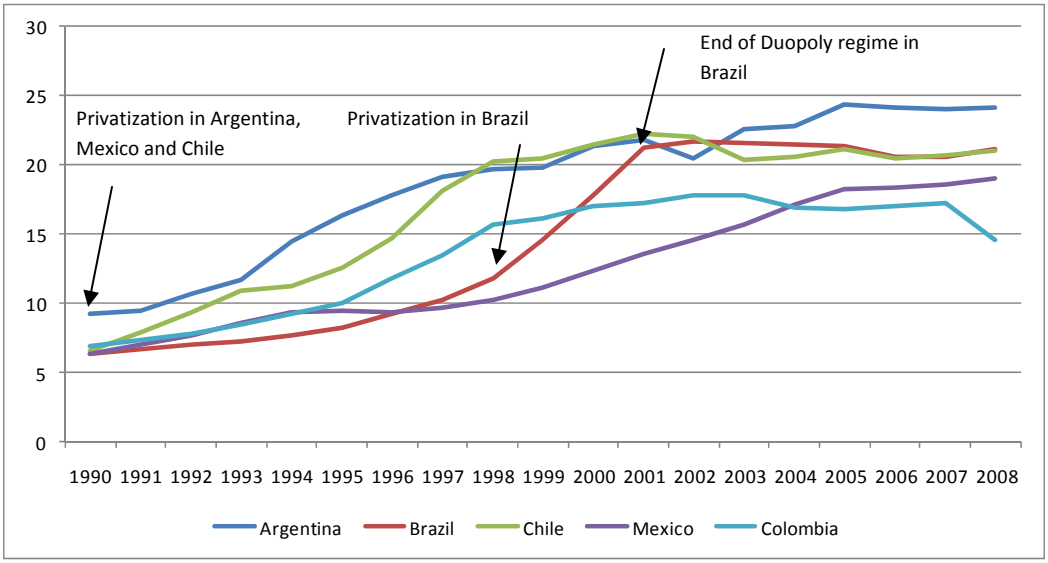


Source: ITU, analysis by the author

This increase led Brazil to reach penetration levels similar to those of other Latin American countries which started the privatization process almost a decade before.

[35] This capacity comprises 22,671 kms of 2/4 fiber pairs.

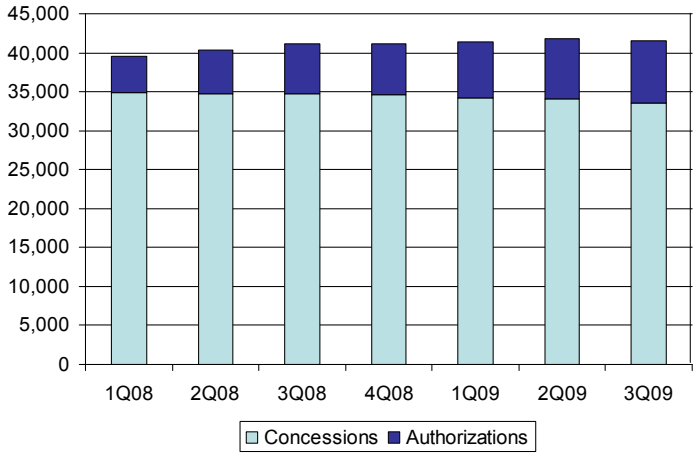
Figure 10: Latin America: Wireline Penetration (1990-2008)



Source: ITU; analysis by the author

The big increase in wireline penetration occurred between 1998 and 2002, the years when the privatized incumbents were competing with the "mirror" companies. Since 2002, after the end of the duopoly regime, the wireline market has experienced a prolonged period of stagnation, which would indicate that all new entrants were targeting a share of existing customers rather than expanding the service coverage. During the last year and a half new entrants and existing license-holders have entered new markets (both of them only need an authorization to operate) not only increasing their market share against incumbents but also reaching new customers who did not have the service before. For example, for 2009, TIM reported that almost 40% of its TIM Fixo customers, the fixed wireless service of TIM, were located in areas where the wireline service was not available (see figure 11).

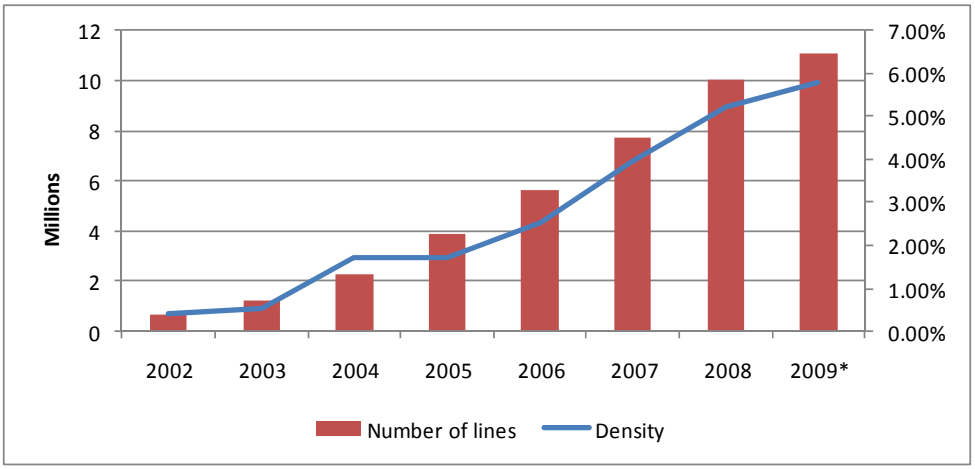
Figure 11. Brazil: Number of Lines per type of concession (in thousands)



Source: Teleco, Anatel

Broadband penetration has exhibited an important growth in the last four years (see figure 12).

Figure 12. Brazil: Broadband Lines and Density

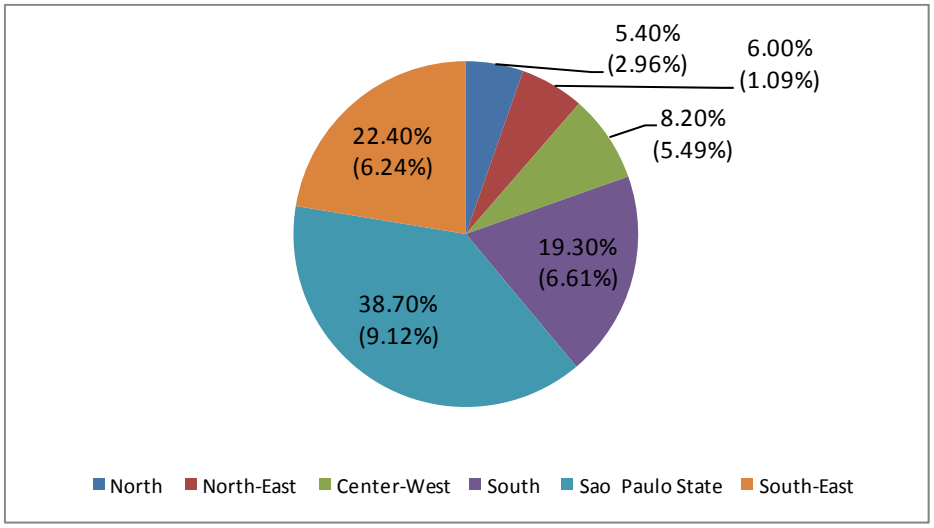


* 3Q09

Source: Teleco; analysis by the author

Despite this impressive growth, there are marked differences among regions. Only three regions contain almost 80 % of broadband connections (see figure 13).

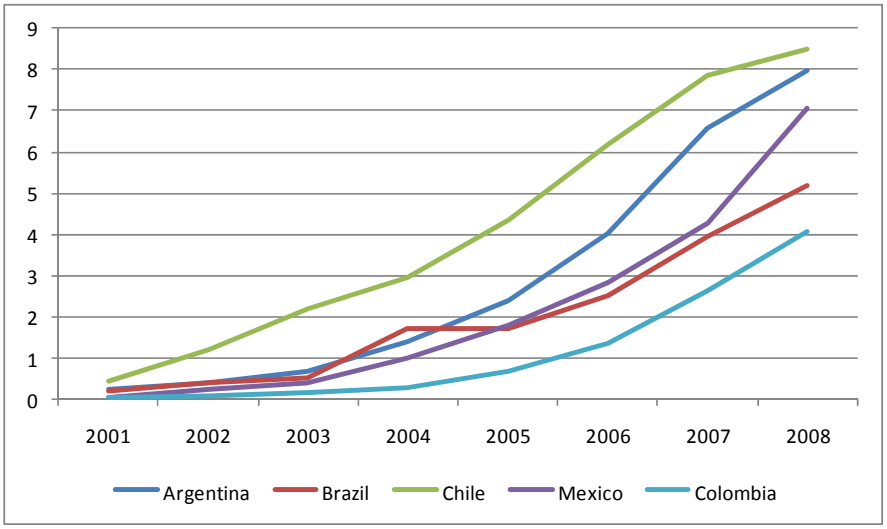
Figure 13: Brazil: Percentage of Broadband Connections per region (Penetration per region)



Source: Teleco, Anatel

Furthermore, regardless of the growth in number of connections in the last four years, there is a difference of almost 3.5 percentage points between Brazil and Chile, a leader in penetration in the Latin American region.

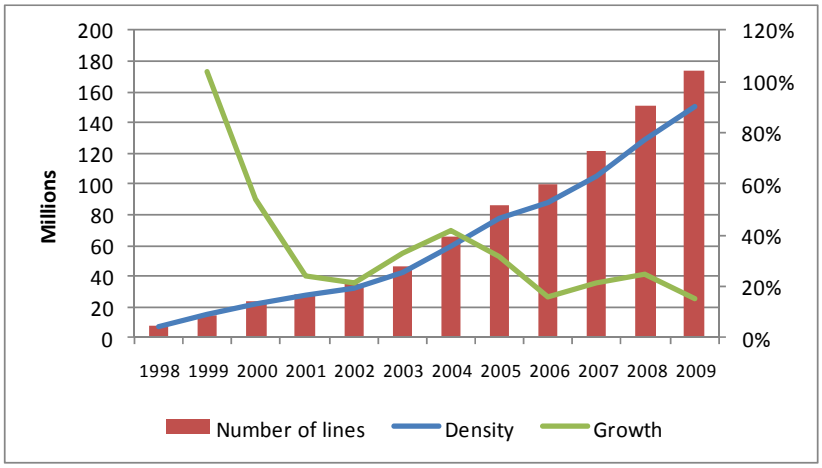
Figure 14. Latin America: Broadband penetration (2001-2008)



Source: ITU; analysis by the author

Wireless penetration has been the biggest success in the modernization of the Brazilian telecommunications sector. It reached almost 90 % in 2009. Despite the effects of the financial crisis, the growth in number of subscribers has remained in the double digits.

Figure 15. Brazil: Wireless Subscribers, Penetration and Growth



Source: ITU, Teleco; analysis by the author

6.2. Innovation

The low penetration of the fixed line broadband has allowed an opportunity for the mobile industry to promote the use of broadband through its 3G network. Brazil is the biggest market

in terms of number of 3G subscribers in the region. By the end of 2009, 3G service reached 3.5% of wireless subscribers, the highest among the more advanced Latin American countries.

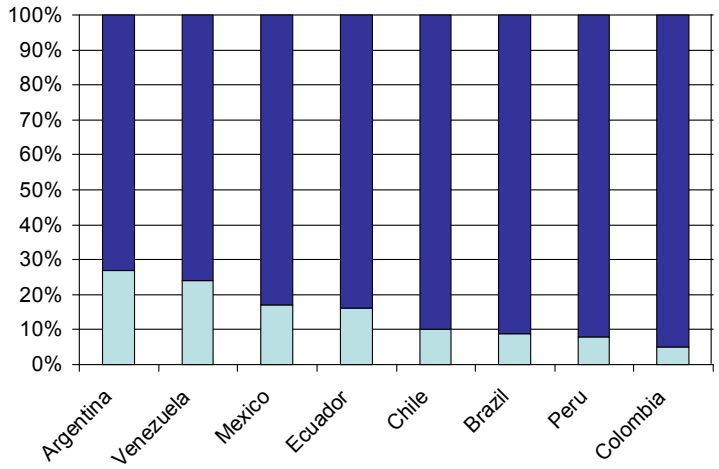
Figure 16. Latin America: Wireless Subscribers and 3G Penetration

Country	Wireless Subscribers (000)	Share of Latin America	Wireless Penetration (per pop.)	3G Subscribers (000)	Share of Latin America	3G Penetration (per subs)
Argentina	48,063	15 %	126.8 %	672	9 %	1.4 %
Brazil	174,854	54 %	90.1 %	6,120	84 %	3.5 %
Chile	16,819	5 %	96.7 %	386	5 %	2.3 %
Mexico	83,808	26 %	79.4 %	125	2 %	1.5 %

Source: 3G Americas (2008); ITU; Merrill Lynch

Despite the size of the market, the share of revenues produced by data is still low in comparison with other Latin-American markets.

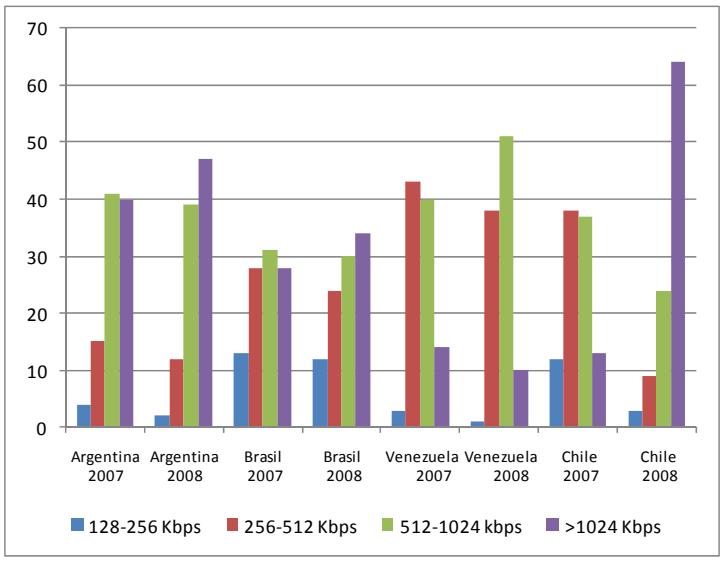
Figure 17. Latin America: Data contribution to ARPU during 3Q08



Source: 3G Americas (2008)

On the other hand, the low penetration of cable TV (5.5% of households) has resulted in limited competition which has impacted the rate of service innovation, when measured by the introduction of faster download speeds. When comparing the 2007-2008 evolution of the distribution of broadband connections by download speed, it can be seen that Brazil has not kept up with the pace of Argentina and Chile, leaders in the region.

Figure 18. Latin America: Comparative Broadband Download Speeds



Source: IDC-Cisco Barometro de la Banda Ancha (2009)

7. Conclusions:

The Brazilian experience is quite conclusive about the value of conducting a reform of the telecommunications sector in which privatization and liberalization are handled simultaneously, both processes driven by a blueprint of market structure. While some features of the Brazilian process were not accounted for in the original intent - sector consolidation and the construction of a "national champion" - most of the design elements contained in the law have been achieved. Wireless telephony achieved near universalization, prices have fallen dramatically and innovation dynamics worked quite well in filling up the gap left by fixed broadband.

What are the critical elements of the Brazilian experience that helped delivering such results? In the first place, the definition of a Telecommunications Law ahead of beginning the reform process. Secondly, the relative independence of the regulatory agency. Thirdly, a shared vision of sector reform that have developed within policy makers that drove the process primarily from the Ministry of Communications.

Not all issues have been solved however. More importantly, the convergence framework still needs to be developed, while the National Broadband Plan will define not only a stimulus plan for accelerating deployment, but could determine the reentry of the state in the sector. A nationally-owned carrier built around resuscitating the Telebras brand could have an impact on sector dynamics. Will it fulfill the role of "carrier of last resort" aiming only to solve for market failures or will it enter competitive markets introducing distortion? That remains to be seen.

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Section IV: Policy and Development of ICT

Part C.2: An ICT Catch-Up Strategy through a State-Owned Sector and Centralized Planning: China

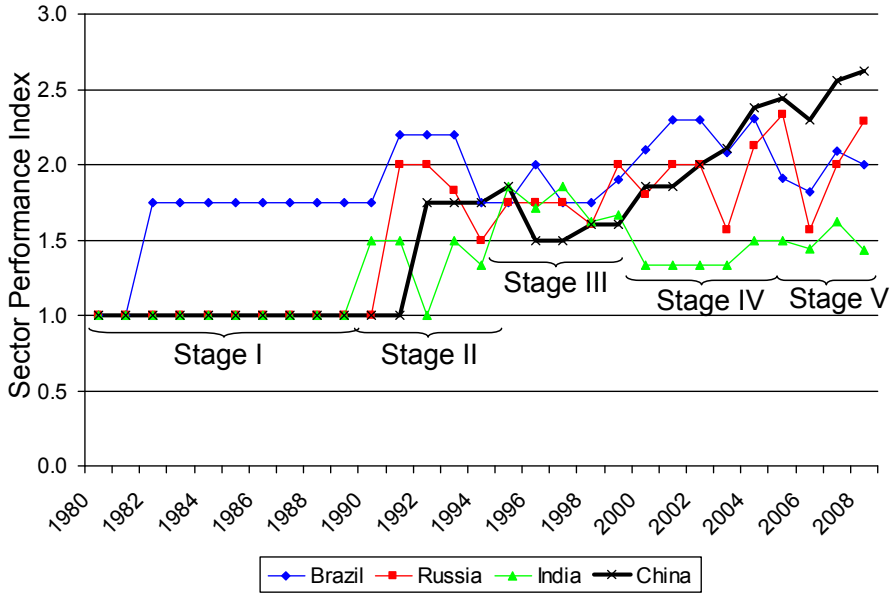
By Raul L. Katz (Columbia University), David Hoffman (The Conference Board), and Kirsten Jaeger (The Conference Board)

1. Introduction:

China has achieved fixed, mobile and broadband network coverage and penetration well above country peers with comparable per capita GDP levels. Growth continues apace with nearly 6 million new mobile subscribers and nearly 1.5 million broadband subscribers added each month. Consequently, China is the largest mobile market in the world in terms of subscribers, and soon to become the largest broadband and Internet market as well (also in subscriber terms, now second only to the United States).

The evolution of China's ICT sector is surprising insofar that major performance improvement started occurring only after 1990. The following chart depicts the comparative evolution of sector performance of the four "BRICs", showing the range of improvement incurred by China's ICT sector in just the last ten years (see figure 1).

Figure 1. Evolution of ICT Sector Performance: China versus BRICs[36]



Source: Katz (2009)

According to figure 1, throughout the 1980s, China was significantly underperforming Brazil. Even during the 1990s when China started improving its ICT infrastructure, it was also lagging behind Russia. In the last decade, however, China started displaying a consistent dramatic improvement in sector performance which led to achieving the top position in its peer group in the last five years.

The explanation of this quantum leap is multifold. Some factors are consistent with those exhibited by other nations. In the policy domain, Chinese policy makers forced network

[36] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.

interconnection to rationalize industry investment and imposed implicit universal service obligations which resulted in mandated deployment to uneconomic geographies and rural areas. On the other hand, to protect the incumbent's market position, the government basically prevented market access by local and foreign entrants, while enacting a regulatory approach aimed at yielding continuous tariff reductions and ever greater penetration and usage.

Similarly, in terms of its adherence to multi-year planning, China has displayed a behavior similar to that observed in Korea, Japan, and in some cases, Sweden. Along those lines, detailed annual planning targets specifying network capacity expansion, coverage, service penetration and quality standards were set while senior policy maker performance reviews were constantly tied to achieving those targets.

Yet, in addition to these common factors, China displayed several highly idiosyncratic factors that are, to a large extent, driven by its political culture. Strong leadership from the top has been a key feature in China's ICT sector. The development of the ICT sector has been controlled by the Ministry of Information Industry (MII), directly supervised by a committee overseen by the Chinese Communist Party. The MII controlled the number of operators, their deployment plans, and, to, a large degree, the performance of its infrastructure suppliers.

In terms of exogenous factors, China's relatively homogenous ethnicity and culture may have contributed to the large-scale uptake of mobile service, and now, broadband. It has overcome difficult, large-area geographic coverage areas with significant new urbanization, and large scale urban modernization – and comparatively late, large-scale network deployment. This has arguably enabled "leap-frog" performance and pace in fixed, mobile, and broadband deployment – an opportunity that China's regulator and operators have astutely exploited. The allure of China's large potential market size has been a key factor driving spirited foreign vendor support for the market (almost to irrational extremes in some cases).

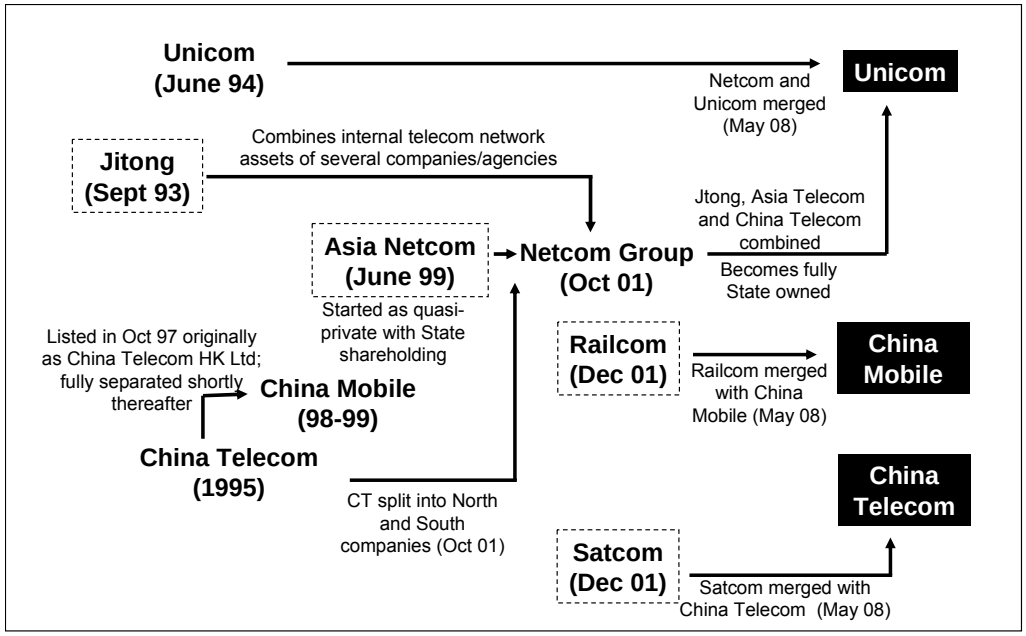
The following case describes not only the policy and institutional approaches but also the intangible factors that have contributed to this quantum leap improvement in sector performance.

2. A state-owned telecommunications sector:

The Chinese telecommunications industry is primarily composed of three carriers: Unicom, China Mobile and China Telecom[37]. All players, though publicly listed in Hong Kong and the U.S. through ADRs, remain majority state-owned. Figure 2 shows the evolution of the industry between 1992 and 2008.

[37] Jiangsu Cable has been recently awarded licenses for the provision of broadband access and other value-added telecommunications services. Similarly, Shenshen Topway (majority owned by China Telecom) is already providing broadband services in the Shenzen market

Figure 2. China: Evolution of telecommunications market structure



Source: Hoffman et al. (2009)

As the figure indicates, the sector has gone from one operator in the pre-1992 period to three operators in 1992-1993 to more than six operators in the late 1990s[38], and now recently back to three large, integrated, full-service operators (China Telecom, China Unicom, and China Mobile) on May 24th 2008, when China restructured the telecom sector for the fourth time since 1992. In addition, after several years of deliberation, in July 2008 the government issued 3G licenses to each of the three newly restructured incumbent, state-owned carriers.

The “forced” restructurings and "CEO changes" by fiat are truly unique Chinese policy features (Hoffman et al., 2009). Adherence to ministerial edicts, forced interconnection rules, and “friendly competition” behavior are assured by “swapping” (or threatening to swap) senior leadership from one operator to another. However, it is worth noting that the ongoing telecommunications sector restructuring is not uncommon in state-owned sectors in China. Airlines, power, resources, industrials – even consumer electronics and wireless handsets – have exhibited similar “expansions and contractions” of state owned players. The regulator’s control of and hands-on adjustment to the competitive structure has been unique and pivotal to the sector’s achievement.

[38] There were other privately-held operators active at that time as well: CITIC, Great wall, SVA, etc

The resulting industry structure comprises not only the three major telecommunications carriers but also some minor, yet growing, cable operators, authorized to offer broadband services (see figure 3).

Figure 3. China: Telecommunications Industry Structure (Market share of subscribers (5/2009)

	Fixed Telephony	Wireless	Broadband
China Telecommunications	60.6 %	5.0 %	52.6 %
China Mobile	6.6 %	73.3 %	---
China Unicom	32.8 %	20.9 %	37.1 %
Other	---	---	10.3 %

Source: Business Monitor International

While the three players offer wireless services nationwide, China Telecommunications offers fixed telephony in Southern China, while China Unicom offers fixed line services in Northern China.

While all three carriers are majority owned by the government, China Mobile has 25.75% of its shares under public control while China Unicom has 20.42 %. In addition, Telefonica owns 5.38 % and SK Telecom 3.79 % of China Unicom (see figure 4).

Figure 4. Main Operators Capital Structure

Player	Chinese State	Public	Foreign Investors
China Telecom	• Government (70.89%) • Guandong Rising Assets Management (6.94%) • Zhejiang Financial development Co. (2.64%) • Fujian State-Owned Assets (1.2%) • Jiangau Guoxin Investment (1.18%) • Others (17.15%)		
China Mobile	• China Mobile (74.25%)	• Public (25.75%)	• Vodafone
China Unicom	• China United Telecommunications (40.92%) • China Netcom Group (24.49%)	• Public (20.42%)	• Telefonica (8.37%) • SK Telecom (3.79%)

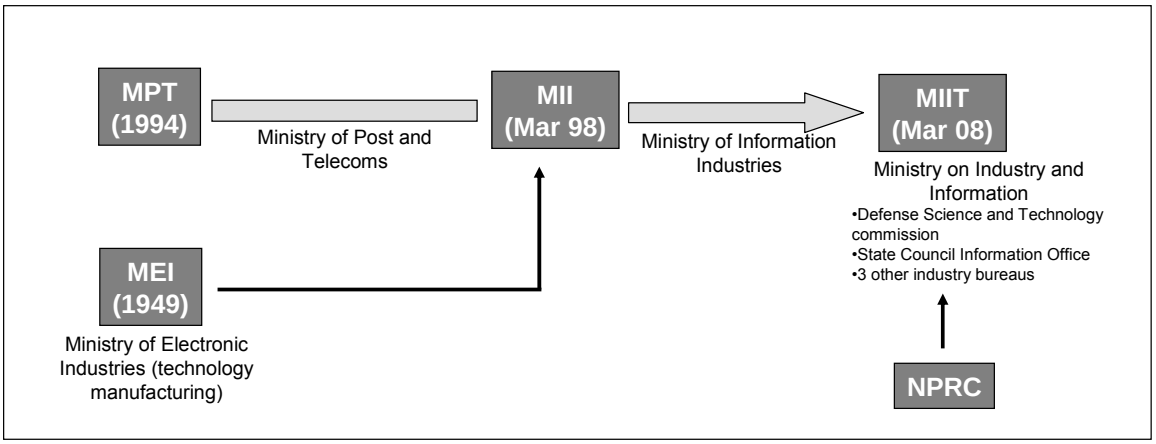
Source: Company websites

While the state maintains control of the operations of all three companies, the presence of different investment funds in the capital structure of these companies has some delaying influence in company decisions.

3. Centralization of planning and control:

In parallel with the restructuring of the industry into a three-player structure, the state has been centralizing its policy and regulatory institutions. Figure 5 shows the evolution of Chinese regulatory institutions.

Figure 5. China: Centralization of regulatory and policy functions



Source: Hoffman et al. (2009)

In the 1990s, the regulation of telecommunications services was conducted directly by the Ministry of Post and Telecommunications (MPT), while telecommunications equipment planning was overseen by the Ministry of Electronic Industries (MEI). Reporting lines between service providers and equipment manufacturers were somewhat blurred since the MPT was also involved in the manufacture of telecommunications equipment, running the Post and Telecommunications Industry Corporation (PTIC) and the Post and Telecommunications Appliance Corporation (PTAC).

The MPT and the MEI were merged in March 1998. By consolidating the Ministry of Electronic Industries (MEI) into the new Ministry of Information Industries (MII), Chinese policy makers aimed at cultivating state-owned champions in the telecom equipment space – ZTE and Huawei primarily – that now enjoy more than 60% market share versus foreign vendors[39]. In 2008, the MII became the Ministry of Industry and Information Technology (MIIT), with similar responsibilities as the MII. Despite the fact that parts of the Ministry of Radio, Film and Television were subsumed within MII, broadcasting and media regulation remains out of MIIT's purview. Therefore, the regulatory entity cannot be considered to be truly "convergent".

[39] While the MIIT does not explicitly control manufacturing, in reality it influences market direction through strict regulation, equipment inspections and recommendations regarding standards.

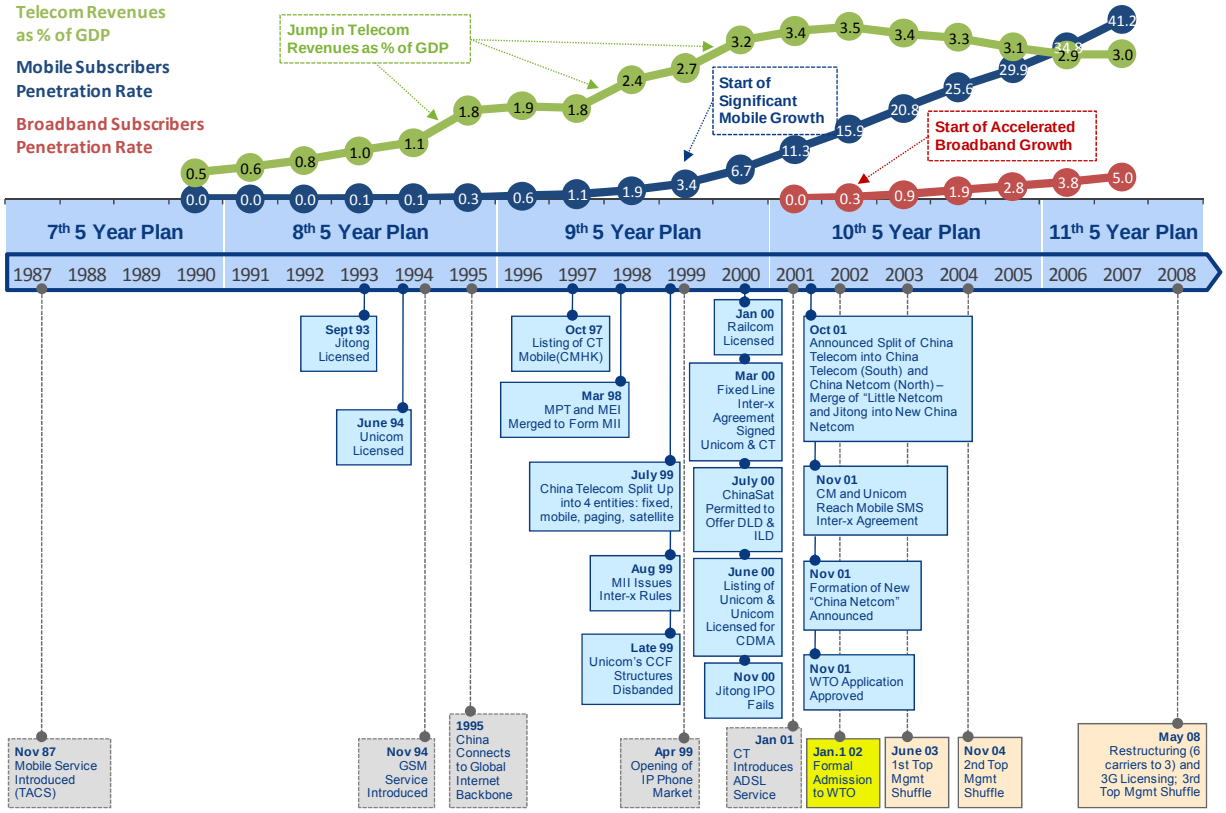
In addition to being centralized at the Ministry's level, all regulatory decisions are completely integrated into the policy domain. Strong leadership from the top has been a key feature in China's ICT sector development. All senior management personnel decisions are controlled explicitly by the Communist Party in order to assure compliance with ministerial (Central/Party) directives[40]. The MIIT reports to the State Council and is member of the State Information Leading Group (SILG). The State Council is the highest administrative governmental entity, representing the central government[41]. The SILG approves and modifies the regulatory framework and future directions for the telecommunications industry. In particular, the role of the SILG has been quite prominent in internet regulation, focusing on controlling web content. While the MIIT is responsible of developing the national telecommunications policy, the internet sector is regulated by the China Internet Network Information Center (CNNIC).

Institutional centralization was reinforced with government-sponsored planning. Detailed annual planning targets specify network capacity expansion, coverage, and penetration and quality standards. Senior leadership performance reviews are tied tangibly to achieving these targets. Figure 6 shows the chronology of key regulatory and policy initiatives in the China that have impacted the market's development and performance over time.

[40] The telecommunications policy agenda has been formulated and driven primarily by ex-MIIT (previously the "MPT") Minister Wu Jichuan during his ministerial tenure from1993-1998. He was arguably one of China's most powerful civil government ministers ever.

[41] The State Information Leading Group was formed in 1995 and is comprised of six senior members who are heads of various government agencies. The functions and powers of the SILG are not formalized, since it is considered to be a "virtual" organization. The SILG has authority to overrule or reverse decisions made by the MIIT (Business Monitor International, 2009). Reporting to the SILG, the State Council Informatization Office (SCIO) acts as its executive arm with a mission to explain and implement communications policy.

Figure 6: Timeline of Key Regulatory and Policy Initiatives in China



Source: Hoffman et al. (2009)

As the figure indicates, successive Five Year Plans have prominently driven developments in the industry, either through restructuring of operators, changes in regulatory institutions, or modification of key rules. The impact of these changes is apparent: the Ninth Plan triggered accelerated development of mobile services, while the Tenth Plan signaled the take off in broadband deployment.

4. ICT policy focus:

China's ICT sector policies are focused around six key guidelines:

1. Forced interconnection and integrated network CAPEX planning (via common designated "telecom research institutes") to limit redundant investment and capital wastage. Under the Administrative Rules on Interconnection between the Public Telecommunications Networks, enacted by the MII in 2001, a telecommunications operator cannot refuse requests for interconnection and must enter into agreements upon request by its peer companies. Furthermore, interconnection agreements cannot be terminated unilaterally without MIIT approval.

2. Implicit USO requirements with essentially mandated rollouts to uneconomic geographies (rural areas) espoused in Village-Connected campaign since 2004 (*"cun cun*

tong"). While there are no specific regulatory requirements relating to universal service, the MIIT has the authority to determine USO by service provider. In addition, the Ministry can determine universal service providers through a tendering process.

3. Deliberately lax enforcement of price floors to enable continued price reduction for end-users and ever greater penetration and usage.

4. Strong-handed control of market access – for both local and foreign aspirants – in order to protect incumbent positions and enable them to carry forth undistracted with basic network coverage expansion. In particular, foreign ownership of carriers is restricted to 49% in basic telephony services and 50% for value-added service providers.

5. Strong control and censorship of telecom networks as media/content channels. Continual scrutiny and subjugation of independent Internet Content Providers to the stewardship of state-owned incumbents. From July 2009, all PCs sold in China need to be equipped with software blocking access to certain websites.

6. Overt structural engineering and re-engineering of the sector's competitive set in order to balance market power and achieve perceived equilibriums. According to rules enacted in October, 2008, Chinese mobile operators must share their network infrastructure among themselves.

In addition to these generic guidelines, China's explicit policy focus, since the mid-90s, has been to "encourage" the state-owned incumbent carriers to expand basic network coverage and lower the cost of service in order to increase penetration and usage. From the onset of network construction in the early 90's, China's implicit policy objectives have been twofold:

1. Achieving network scale as measured by the number of ports, capacity, kilometers of fiber, subscribers, traffic volume, etc.

2. Maintaining market control in the hands of a small group of large, Communist Party-controlled, state-owned incumbents.

In order to accelerate the implementation of network deployment plans, the government focused incumbent players on buying infrastructure equipment in large volumes at very low prices by: (1) forcing foreign equipment vendors into cut-throat competition with one another, and (2) compelling these players to enter into joint ventures with Chinese manufacturers to stimulate technology transfer, strengthen local support, and continually reduce pricing. More importantly, the government applied strong pressure on international equipment providers and IP owners to continually lower prices and provide global "best price" for China. Finally, the government was able to offset network construction costs for carriers by utilizing military and city-level civil construction personnel at negligible cost.

This way, China was able to undertake large-scale network CAPEX without foreign funding. Funding was further strengthened by an IPO market in the late 90s and early 2000s that was serendipitously receptive to Chinese issues of all types, particularly from the telecommunications sector.

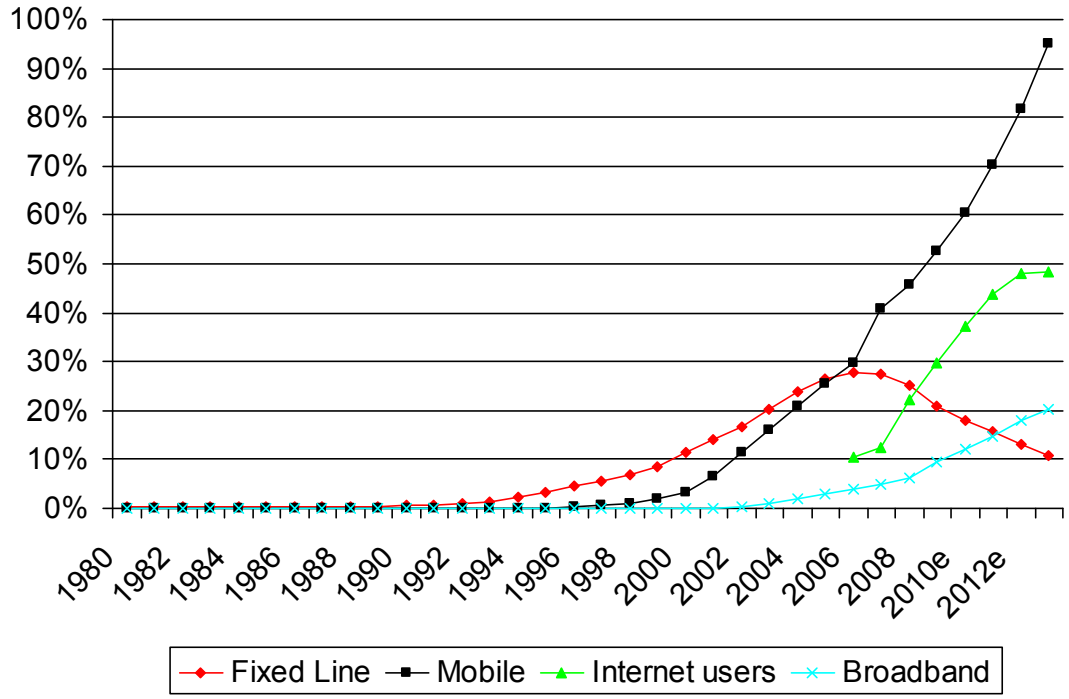
Going forward, strategic policy priorities include:

- Completing the recently implemented industry restructuring
- Ongoing efforts to merge telecom and CATV networks and operations (which is contested by the Broadcast Authority, SARFT)
- Limiting the growth of a cohort of private Internet upstarts who are gaining some scale (by virtue of public listings in the U.S.)
- Intensifying support for local producers and indigenous technologies
- Pushing the three incumbent carriers to roll out 3G mobile (licensed in January 2009) on a large scale and at an unprecedented pace (as one component of economic stimulus).

5. Resulting sector performance:

China has achieved a remarkable growth of fixed, mobile, and broadband Internet services (Figure 7).

Figure 7. China: ICT Penetration (1980-2013e)



Sources: National Bureau of Statistics (China); ITU; MIIT website; CNNI; .Business Monitor

As of June of 2009, there were 672 million mobile subscribers, equivalent to 52% penetration. Service penetration in the cities had reached saturation levels (in Beijing mobile penetration is 105%, while in Shanghai it is 108 %). This is why most carrier investment is now focused on expanding service to rural areas. Chinese policy makers have formulated a target penetration of

95% by 2013. The three mobile carriers are now rolling out their 3G networks at an unprecedented pace and scale – encompassing capex in 2009 and 2010 estimated to be upwards of USD 40bn. Despite the state-owned position in each carrier, they actively compete to gain position in the mobile market to extent that price wars are being waged.

As of May 2009, there were 331 million fixed access lines (equivalent to 23 % penetration). Access lines have been declining as a result of mobile substitution. The regulator has attempted to reduce the rate of decline by lowering interconnection rates with the objective of preventing cross-elasticity between both services.

By May 2009, China comprised 91 million broadband subscribers (6.2 % of inhabitants, 21.2 % of households). It had experienced a 25 % growth since 2008 (Business Monitor International, 2009). Broadband growth is fueled both by DSL platforms, cable competition and wireless broadband. According to the CNNIC, approximately 39.5 % of Chinese internet users have accessed the platform through mobile devices.

Convergence is limited to a handful of trials, and remains the subject of intense bureaucratic infighting and policy vagary. China's "Indigenous Innovation" campaign is intensifying, arguably to limit royalty payments to international IP owners, as evidenced by China Mobile – the largest carrier in the world – being licensed for China's own 3G technology, TDS-CDMA. Initial performance is very poor, but China Mobile continues nonetheless to invest significantly.

The Chinese mobile value-added services market is also growing. As of June 2009, the China Internet Network Information Center (CNNIC) reported that there were a total of 338 million internet users. Of those, approximately 10 % use Instant Messaging, while 9 % access search engines and 10.5% access online news. However, China's telecommunications value-added services market is significantly constrained by regulation and under-developed service offerings. Enterprise managed services are nascent. Offerings from incumbent carriers are seen as being deficient; and most large enterprises self-manage their LAN/WANs and associated applications (at high cost). Consumer data/multimedia services are growing strongly in some categories that are on the periphery of constraining regulations – e.g. gaming (8.4 % of users), chat, blogging – but these areas are subject to continual regulatory scrutiny and uncertainty. Demand in China is robust, and some domestic third party ICPs (Internet Content Providers) have publicly listed in the U.S., and gained sufficient scale enough to defend and capture turf from incumbents (e.g. Sina, Sohu, Netease, Tencent, Baidu).

Incumbent telecom providers are making explicit efforts, at the behest of Party media regulators, to subsume and control these services within their spheres of influence (access portals, gateways, application servers, and the like). Media and financial networks are underdeveloped and fragmented. CATV digitalization is significantly behind schedule, and multimedia content services are nascent.

6. Conclusions:

The development of China's ICT sector is clearly a success story both in terms of penetration achieved and the time that it has taken to reach this point. Undeniably, this success is linked to the strong role provided by the state in driving the policy agenda and implementing it. While other countries exhibit a strong state-driven ICT development process, the Chinese growth pattern is linked to the specific characteristics of the country's state and policy-making process.

At 52.6% mobile penetration (population) and 21.2% broadband penetration (households) China arguably has substantial headroom to continue to develop via continuance of its current policy agenda. Given the current development vector, further growth will be achieved.

A critical issue in the Chinese model is the extremely close linkage between industrial policy, services regulation and industry structure. While in general terms, the coupling of these three elements could result in harmonious sector development, in some cases it gets in the way of pursuing industry growth. A case in point was the linkage between the restructuring of the industry and the choice of 3G standard. Since the development of the Chinese standard (TDSCDMA) was delayed for some time, this had an impact in the assignment of 3G licenses to the restructured carriers. As a result, the industry restructuring (which started to be discussed in 2004) was finally implemented in 2008, therefore delaying the launch of 3G services.

Another limitation of the Chinese approach could emerge in the applications domain. The strict control of information flows could stifle the flourishing of value-added services beyond the strictly transactional or entertainment driven. At the value-added services level, China's market is significantly constrained by regulation and underdevelopment of services. Enterprise managed services are nascent. Offerings from incumbent carriers are seen as being deficient, and most large enterprises self-manage their networks and associated applications with significant cost penalties. Consumer data and multimedia services are growing strongly in some categories that are on the periphery of the regulatory framework (e.g. gaming, chat, blogging) but these areas are subject to continual regulatory scrutiny and uncertainty. Demand for these services in China is robust and some domestic independent Internet Content Providers (e.g. Sina, Sohu, Netease, Tencent, and Baidu) have gained sufficient scale and access to capital markets in the U.S. to defend and capture turf from the incumbents. On the other hand, incumbent telecom providers are making explicit efforts (at the behest of media regulatory authorities) to subsume and control these services within their spheres of influence (access portals, gateways, application servers and the like). Media networks are still underdeveloped and fragmented, while the digitalization of cable TV networks is behind schedule. Finally, convergence is limited to a handful of trials and remains the subject of intense bureaucratic infighting and policy uncertainty.

To conclude, China's policy has clearly been successful for deploying infrastructure. This policy will still provide the appropriate framework for continuing growth in mobile and broadband penetration. The issue remains how the government will deal with necessary changes in the policies promoting the development of services and applications. Given the dialectic relationship existing between value-added services and telecommunications infrastructure, it

will be interesting to watch how the government tackles this issue. If it does not, that might have an impact on the country's ability to further the "informatization" of the economy, the development of a business process outsourcing industry, and the development of other sectors such as financial services hub and software.

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Section IV: Policy and Development of ICT

Part C.3: A Guiding Vision for Building an Information Society: Estonia

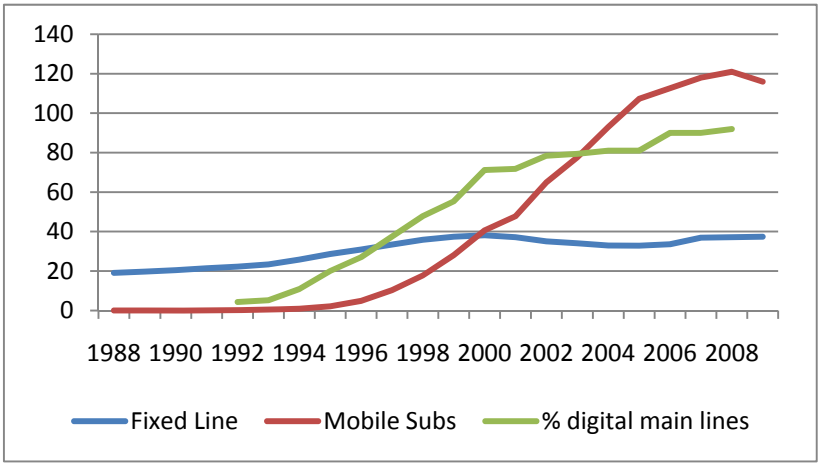
By Raul L. Katz (Columbia University)

1. Introduction:

Estonia has historically been a center of ICT innovation even under the Soviet regime. Acknowledging the need to develop information technology in support of the oil and energy sectors, the Soviet Union started building in this country an embryonic R&D cluster. For example, in 1960, the Institute of Cybernetics was founded to support research and education in computer engineering. In the ensuing decades, Estonia became a center of education, research and development of ICT. However, the availability of technologically sophisticated labor force and research facilities lacked the much-needed ICT infrastructure. This imbalance became apparent in 1991 at the time of dissolution of the USSR.

Estonian policy makers, well aware of this limitation and cognizant of the potential the country had to become a technology cluster, identified ICT infrastructure as a target for development. As a result of a concerted policy effort, in less than fifteen years Estonia succeeded in building a state-of-the-art telecommunications system (see figure 1).

Figure 1. Estonia: Penetration of Communication Services (per population)



Source: ITU, BMI 2010 Report

In addition to the conventional policy factors, such as competition and privatization, a target vision for the development of an information society, formalized in a strategic plan, and an emphasis on digital inclusion were key success factors of the Estonian model.

2. Context:

Despite being a "late starter" in the transition to an ICT intensive society, the Estonia ICT sector presents an above-average performance when compared to the EU and the OECD averages (see figure 2).

Figure 2. Indicators Estonia ICT sector performance (2008)

	Population Penetration			Household Penetration		
	Estonia	EU	OECD	Estonia	EU	OECD
Fixed Line Adoption	37 %	46 %	43 %	86.8 %	70 %	72 %
Wireless Subscriber penetration	116 %	83 %	99 %			
Broadband penetration	26 %	23 %	22 %	63 %	49 %	60 %
Personal Computers	55.5 %	46 %	54 %			

Source: Euromonitor, OECD Broadband Portal, Eurostats

Fixed-line telecommunications have reached an adoption level of 37 % per population, while wireless telephony exhibits 116 % penetration. Broadband penetration has reached an adoption of 63% per household while personal computers achieved an adoption of 55 % per population by 2008.

Despite its considerably lower level of economic development, Estonia's ICT sector performance is superior to that observed in other industrialized countries such as France and Germany (see figure 3).

Figure 3. Economic Development versus ICT sector performance (2008)[42]

Country	GDP per capita	ICT Performance Index[43]
Denmark	62,579	3.44
Sweden	52,305	3.43
United States	46,194	3.13
Canada	45,278	2.57
United Kingdom	43,472	3.12
Estonia	17,532	2.90
France	41,508	2.71
Germany	40,182	2.86

Sources: World Bank; analysis by the author

Estonia's achievement is even more surprising given that the country presents a lower level of urban concentration (69%) than Germany (75%) and France (77%), and exhibits a low level of population density (32%), both exogenous factors that would make the diffusion of ICT difficult[44].

In summary, when controlled by income, density and urban concentration factors, the level of ICT adoption shown in Estonia has to be explained by other factors such as intense competition and/or specific government policies

[42] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.
[43] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.
[44] On the other hand, Estonia is one of the smallest countries in Europe in terms of population (1.3 million) which favors the coverage of ICT.

3. Policy objectives:

In 1991, when Estonia declared independence from the Soviet Union, the government of the new republic saw the deployment of a communications network as a critical strategy for the protection of the newly gained sovereignty. Still under the ruble system, and facing a negotiation process for the withdrawal of Russian troops, Estonia decided that the deployment of a mobile network would be the less expensive and fastest way to deploy a national communications system. In this context, the Ministry of Communications established a joint venture with the national operators of Sweden and Finland for the deployment of a mobile network, which became operative in July 1991.

In December 1992, after a new currency system was established and a period of relatively stabilization was in place, the government created a consortium, Eesti Telekom, between the Ministry of Communications (51%) and two Nordic operators, Telia and Sonera (49%)[45]. This new consortium was in charge of running the new wireline carrier, Eesti Telefon, and was responsible for the deployment and upgrade of the network. The new company was awarded with a monopoly for the exploitation of the local and long-distance service until 2000.

Having concluded the organization of the mobile and wireline networks, Estonian policy makers turned their attention to adoption of technology. ICT diffusion had been seen as a priority for the Estonian government since the 1994. The first project aimed for adoption of ICT was launched in the education arena in 1997. However, the first integrated effort to create an information society was defined in 1998, when the parliament adopted the *Principles of Estonian Information Policy*. In this document, the government outlined the multidimensional impact of ICT on Estonian society. According to this, the formation of an information society should help:

- Promote and ensure democracy in the Republic of Estonia;
- Support the development of an information infrastructure;
- Support the creation of a competitive economy;
- Support the development of Estonian culture and language; and
- Support the modernization and improvement of state defense as a result of developments in information technology

This bill was further refined by the *Principles of Estonian Information Policy 2004-2006*, elaborated and approved in 2004 and the *Estonian Information Society Strategy 2013,* approved in 2006. In the 2013 Strategy it was established that by 2010, all public sector

[45] In 1998, The Estonian government sold 26% of its participation to private investors.

websites will comply with Web Accessibility Initiative (WAI) quality criteria. In addition, the following specific goals were established to be fulfilled by 2013:

- 75% of Estonian residents will be using the internet, while household internet penetration will amount to 70%;
- The productivity per employee in Estonian enterprises will account for 75% of the EU average;
- The share of ICT enterprises in the national GDP will amount to 15%;
- Citizen satisfaction with public sector e-services will reach 80%; and
- Satisfaction of businesses with public sector e-services will be 95%.

4. Review of policy approach and tools:

The policy initiatives launched by the Estonian government to fulfill the objectives reviewed above are grouped in two categories: development of competition to achieve the construction of a state-of-the-art ICT infrastructure and promotion of adoption of ICT in order to address the digital demand gap.

4.1. The development of competition:

Competition in the mobile market was introduced in 1995, when a second GSM operator, Finnish Radiolinja (Elisa), entered the market. In May 1997, a third GSM operator entered the market, Ritabell (Tele2). These two new operators quickly gained market share through fierce price competition that boosted service adoption.

The two most important telecommunications reforms to open the way to liberalization were enacted in 1999 (*Cable Distribution Act*) and 2000 (*Telecommunications Law*). In both pieces of legislation there was an explicit search for the creation of a competitive environment. The *Cable Distribution Act* established that the owner of a cable television network must not be a trading company holding more than 40 % of turnover of telephone services[46]. The *Telecommunications Law* of 2000 allowed regulatory authorities to impose special obligations and conditions to firms controlling more than 25% share of a telecom market. As a result of these two bills, all markets but the fixed telephony one can be characterized as having high competition levels (see figure 4).

[46] In that moment Telia (Sweden) had a 60% participation in the Cable provider Starmanm which had 41% of the market. After the Cable Distribution Act was passed, Telia could not have any participation in the cable business because it had a 24.5% participation in Eesti Telekon.

Figure 4. Estonia: Operator market shares (2Q09)

Company	Market Share		
	Fixed	Mobile	Broadband
Telia Sonera	92%	47.2%	53%
Tele2		30.9%	
Elisa Eesti		21.9 %	
Starman			19%
STV			13%
Other			15%

Source: BMI 2010 Report, Statistics Estonia

4.2. The ICT Strategic Plan:

The Estonian Information Society 2013 strategy focuses on three demand stimulation areas:

- Citizens: the development of a citizen-centered and inclusive society, which focuses on broadening access to digital information and improving skills and opportunities for participation;
- Business: the development of a knowledge-based economy, which aims to increase ICT penetration in all economic sectors and the competitiveness of the ICT sector; and
- Public administration: the development of a citizen-centered, transparent and efficient public administration, that functions efficiently while collecting, using and maintaining data necessary for ensuring the provision of public goods in a common and systematic manner.

Each area subsumes a number of programs that, in some cases, were launched prior to the formulation of the strategy.

4.2.1. Citizen-centered and inclusive society:

The government has implemented several programs to address the digital demand gap. The Tiger Leap and Tiger Leap Plus (1997-) projects were focused on including ICT in the education curricula. The first goal of the project was to provide connectivity to all schools in Estonia, reaching this milestone in 2000. After this, the programs have evolved in several directions, such as improving ICT infrastructure in school, educating teachers in the

integration of ICT into the learning process and creating software for the improvement of learning. The current stage of the program has focused on the development of e-learning.

In addition, the government has been developing programs to take ICT to underserved areas. The program KülaTee3 (2005-2007) was launched to bring broadband connectivity to rural areas where private investors had no intention to offer the service. Using wireless technology, at a cost of more than 1.5 million Euros, the program connected rural areas in more than 15 counties. Another project has been developed by Eesti Energia, using CDMA technology to offer broadband connectivity for 19 euros per month.

In August 2009, the Estonian Minister of Economic Affairs and Communications and the Estonian Association of Information Technology and Telecommunications (ITL) signed EstWin, a development project that intends to make 100 Mbps wide-band internet accessible to every citizen of the country by 2015. The first goal is to guarantee 100 Mbps connections for 98% of population and companies by 2012. The estimated cost of the project is 384 million Euros with a quarter of the budget coming from the public sector and is expected to be covered from the Structural Funds of the European Union while the rest would be financed by the companies supporting the ITL, such as Elion, Elisa, EMT, Starman, Levira, Linxtelecom and others.

Private initiatives have also been included as a part of the government effort to bring ICT to all sectors of the population. The best-known example is the Look@World Foundation. Established in 2001 by a group of leading ICT companies, the program aims to considerably increase the number of Internet users. Initially, the project provided computer and Internet training for 100,000 citizens and opened nearly 500 public Internet access points. The goal for 2008 was to provide training courses to different groups of the population, with the objective of training an additional 300,000 inhabitants (about 25 per cent of total Estonian population).

4.2.2. Development of a knowledge-based economy:

The government has structured the ICT economic impact effort in two areas: to promote ICT uptake by enterprises, and to increase the competitiveness of the Estonian ICT sector. The core of the initiatives aiming to increase adoption has been the development of platforms that allow the interaction between the government and enterprises for e-business transactions.

The second area is targeted to create a domestic technology cluster. More than 80% of the turnover of the ICT manufacturing sector in the country is consolidated in eight companies

owned by Swedish or Finnish capital, such as Elcoteq[47] and JOT Eesti OÜ (Finland) or Ericsson (Sweden). Because R&D activities are conducted outside Estonia, the country is being conceived as part of the Nordic cluster with a manufacturing role, rather than becoming an ICT cluster by itself (Kalvet, 2004). The government's first step to change this trend has been to sponsor the Competence Centre in Electronics-, Info- and Communication Technologies (ELIKO) in 2004. This centre is formed by Tallinn University of Technology and private companies and its aim is to increase the quantity and level of ICT research in Estonia.

4.2.3. Efficient public administration:

Since the beginning of the decade the Estonian government has been at the forefront of introducing e-government programs, such as the "e-tax board/customs" platform (2000), the introduction of the Digital Signatures Act (2000) the electronic ID card (2002)[48].

With this last effort, every user gets assigned an official e-mail address that allows a direct communication channel between the citizen and the government. The success of this policy has been astonishing. By 2008, more than 90% of tax returns were filled using the electronic platform. In 2009, almost 10% of the people with the right to vote did so through the "e-voting" platform developed by the government.

5. Resulting ICT Sector performance:

The Estonian policies have been extremely successful in promoting adoption of ICT technology. By 2009, more than 75% of population was using the Internet, 67% of households had a personal computer at home and 91% of personal computers were connected to the Internet. However, as shown in figure 5, the government digital inclusion policies have had varying results by age groups.

[47] Only Elcoteq represent more than 36% of the labor in the ICT industry. In July 2009 most of Elcoteq's Tallinn plant was acquired by Ericcson. Elcoteq had been supplying radio access products to Ericsson's 2G and 3G base-stations together with optical- and transmission equipment for almost 10 years.

[48] Currently, more than 1.03 million of ID cards have been emitted.

Figure 5. Estonia: ICT Skills by age group (% of age group)

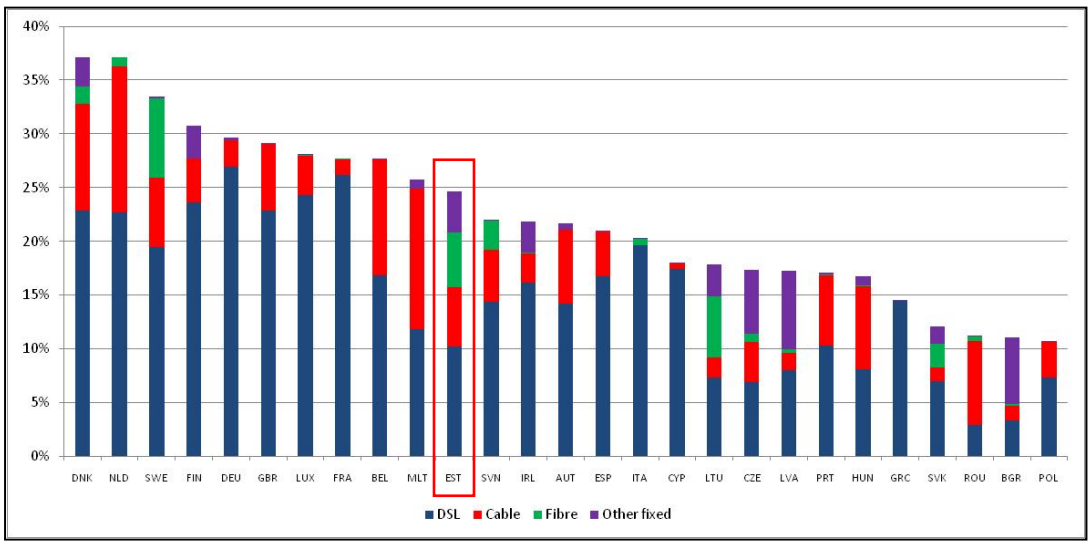
TYPE OF SKILLS	AGE GROUPS					
	16-24	25-34	35-44	45-54	55-64	65-74
Using a search engine to find information	89.31	81.22	72.58	53.05	32.97	14.65
Sending e-mails with attached files	92.27	83.45	68.05	47.21	29.4	11.8
Posting messages to chatrooms, newsgroups	84.12	63.5	45.27	28.94	14.36	5.11
Using the Internet to make telephone calls	53.66	46.37	30.4	17.74	7.96	..
Using peer-to-peer file sharing for exchanging movies, music, etc.	44.68	37.24	20.34	13.28	5.8	..
Creating a web page	39.96	28.91	16.31	10.62	3.51	..

Source: Statistics Estonia (2009)

In addition to adoption of e-Government applications, adoption of ICT platforms has led to high usage of private sector ICT applications. For example, by 2009 98% of banking transactions were conducted electronically and more than 1.5 million clients used the Internet-based banking systems.

In addition to the successful adoption of ICT infrastructure and services among the Estonian population, the regulatory framework enacted in Estonia has contributed to the development of a very active platform-based competition model among cable, mobile providers and the incumbent to gain a share of the broadband market. (see figure 6)

Figure 6: Comparative Broadband Penetration by type of technology (1Q09)



Source: ECTA, (2009); analysis by the author

With the introduction of FTTH by Elion and Docsis 3.0 by Starman, a fierce competition for customers developed during 2009. Currently the only way to acquire broadband services above or near 15 Mb is through bundling with phone and digital TV. (See figures 7)

Figure 7: Estonia: Bundling Rates

Provider	Low-end		Medium		High-end	
	Download Speed	Price (Euro/ Month)	Download Speed	Price (Euro/ Month)	Download Speed	Price (Euro/ Month)
Starman	1.5 Mbps	19.11	18 Mbps	25.50	100 Mbps	38.27
Elion	1 Mbps	16.55	12 Mbps	29.52	100 Mbps	35.91

All prices include VAT

Exchange rate: 15.65 Kr per Euro

Source: Companies' websites; analysis by the author

It is interesting to note that because the incumbent could not compete in the pay-TV market by acquiring a pay-TV company, it had to upgrade its network to be capable of offering video distribution through Internet Protocol TV services (IPTV) and in this way use the bundling of products to decrease the effect of fixed/mobile substitution.

6. Conclusion:

The Estonian experience is a clear example of a successful quantum leap in ICT sector performance by combining infrastructure development through platform-based competition and demand-gap programs. In addition, the deployment of initiatives in both areas was supported by the formulation of an overarching strategy aimed at building an information society.

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Section IV: Policy and Development of ICT

Part C.4: The Impact of Long Range Planning and Platform-Based Competition: Japan

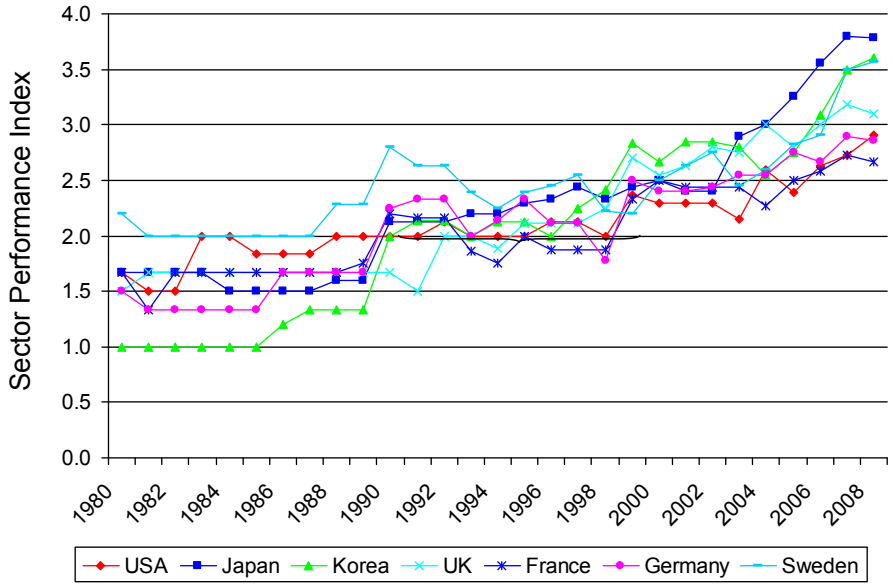
By Raul L. Katz (Columbia University)

1. Introduction:

The Japanese ICT sector is one of the world's top performers in terms of telecommunications service adoption, quality, productivity, and innovation. In June 2009, fixed broadband penetration was 24% (65 % per household), while the penetration of wireless broadband was 76%. Japan is the world leader in fiber optic subscriptions (45 % of broadband access), which results in some of the world's fastest download speeds and lowest prices. The leadership in broadband is consistent with a top performance position in mobile services. In February 2009, Japan exhibited a wireless penetration of 89.4 %.

A comparative analysis of the performance of Japan's ICT sector since the 1980s against those of other industrialized countries indicates a consistent trend aimed at achieving a leadership position, a goal achieved after 2004 (see figure 1):

Figure 1. Japan vs. other industrialized countries: Evolution of ICT Sector Performance[49]



Source: ITU; analysis by the author

The comparative analysis of sector performance of Japan versus other industrialized countries between 1980 and 2008 indicates three clearly defined stages. Between 1980 and 1990, Japan underperformed several industrialized nations: the U.S., the U.K. and, at some points in time,

[49] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.

France and Germany. This situation was partly due to Japan's moderate fixed telephony penetration, which ranged between 34% in 1980 and 44% in 1990, while the United States reached 53% in 1990 and France 49%. In the same year, the penetration of mobile services in the United States and the United Kingdom was 2.5 times higher than Japan's. Beginning in 1990, Japan's ICT sector performance started improving dramatically, catching up and sometimes surpassing its peers. By 1995, Japan achieved parity with the U.K. and Germany in terms of its fixed line penetration, although it still lagged the U.S. and France. By the end of the second decade in this analysis, however, Japan's ICT development vector enabled the nation to exceed the performance of the U.S. and Germany and match those of Sweden and France. By the year 2000, wireline penetration had reached 48 %, wireless 52 % and broadband 0.67 % (IS LESS THAN ONE PERCENT CORRECT?). From then on, Japan's infrastructure deployment and service adoption improved dramatically, moving ahead of all of its industrialized peers, outperforming them in almost all ICT sector metrics after 2005.

Several policy variables explain this change in leadership position, although, as in the case of Korea, an industrial policy guided by a vision of the country's technological future appears to be the overarching guiding factor. The focus of this case study is to assess the policies that allowed Japan to achieve its superior performance, emphasizing in particular the factors that are specific to this country. At a high level, four policies explain Japan's dramatic improvement in ICT sector performance:

- Consistent and effective government policy aimed at building a state-of-the-art ICT infrastructure base serving all segments of the population;
- Privatization of the telecommunications incumbent and liberalization aimed at fostering the entry of facilities-based competitors;
- Industrial policy targeted for development of an export-oriented technology base sector; and
- Government intervention in the promotion of infrastructure deployment.

The following case study reviews the specific policies and planning efforts implemented by the government, and the results achieved.

2. Context:

The Japanese ICT sector is, at present, one of the most advanced in the industrialized world (see figure 2).

Figure 2. Indicators of Japanese ICT sector performance (2009)

	Population Penetration			Household Penetration		
	Japan	EU	OECD	Japan	EU	OECD
Fixed Line Adoption	40 %	46 %	43 %	97.4%	70 %	72.%
Wireless Subscriber penetration	89.4 %	83 %	99 %			
Broadband penetration	24.2 %	23 %	22.8 %	65%	49 %	60%
Personal Computers	52.3 %	46 %	54 %			

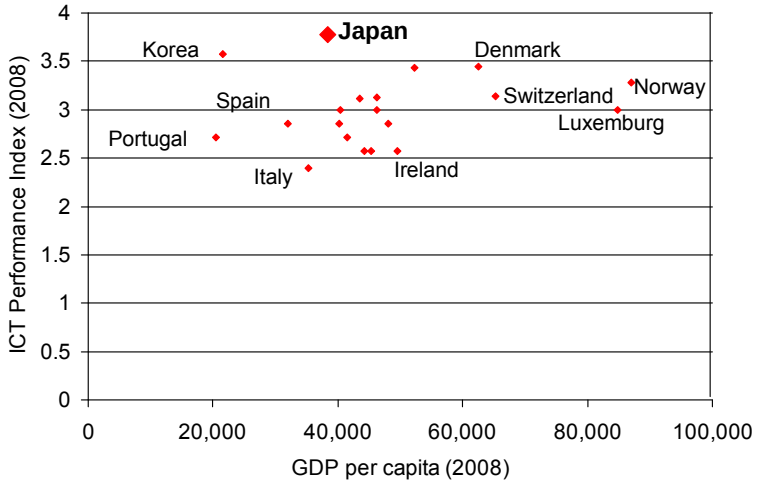
Sources: ITU (2009); OECD Broadband portal; Merrill Lynch; Euromonitor International

Fixed-line telecommunications have reached an adoption level of 40 % per population (or 97.4 % per household), while wireless telephony exhibits 89.4 % penetration. Broadband service reached an adoption of 24.2% of inhabitants (65 % per household) in 2009[50].

One of the striking features of this performance is that, while being an OECD country, Japan remains at the mid-range of high-income industrialized countries. When compared with other developed countries of higher GDP per capita, Japan ranks higher than the latter in terms of ICT sector performance (see figure 3).

[50] Part of the reason why Japan is so close to the OECD average when it comes to broadband penetration could be that a relatively low percentage of its population (66 %) resides in urban areas (Atkinson et al., 2008).

Figure 3. Economic Development versus ICT sector performance (2008)



Sources: World Bank; analysis by the author

Japanese ICT sector performance is directly linked to a mix of industrial policies, active government intervention and the promotion of platform-based competition. The following section will outline the policy objectives and tools that were instrumental in achieving this leading position. After reviewing the policies, we will examine how they have played out in the development of both the mobile and broadband sectors.

3. Policy objectives:

Japan has, since the year 2000, espoused the objective of developing an advanced ICT sector. In 2000 the government established a national goal of "creating a society based on highly advanced telecommunications networks". Formulated in the *Basic Law on the Formation of an Advanced Information and Telecommunications Society,* the principle was supported by the specific objective to "reduce gaps in opportunities to access information and communications technology, and the ability to use such technology".

The universalization objective was gradually fine-tuned in the course of successive government strategies resulting in the end in the general target of achieving "ubiquitous access to ICT". Recent Japanese strategies for the ICT sector embrace two key objectives:

- Realization of a self-sustaining ICT Society
- Realizing a ubiquitous network society

ICT ubiquitous access has been constantly linked to digital literacy and training. Along those lines, it is considered that ICT sector leadership is not only driven by infrastructure

deployment but also to development of "human resources with expert knowledge and skills in the fast moving ICT sector" (MIC, 2001).

Despite the country's extensive deployment and adoption of ICT the Japanese government is still focused on addressing the broadband “digital divide”. As of 2007, 5% of all households still were not covered by broadband services. To address this problem, the Ministry of Communications launched a “Next generation Broadband Strategy" with a target of achieving 100% broadband coverage by 2010 through deployment of a Wimax platform.

4. Review of policy approach and tools:

To achieve the universalization objectives reviewed above, the government has implemented a privatization and liberalization policy, with the objective of developing a platform-based competition model. This policy framework was combined with an active role in sector planning, which stipulated areas of targeted intervention.

4.1. Sector liberalization and incumbent privatization:

The first step towards liberalization took place in 1984, with the enactment of the *Telecommunications Business Law* (TBL). This bill defined two categories of providers: Type I companies would provide telecommunications services by installing and operating their own telecommunications circuits; Type II companies without their own circuits would offer different, valued-added options to the telecommunications service provided by Type-I carriers. Although the TBL formally ended the monopoly in telecommunications, there were several constraints on the introduction of competition. Among them was the cap to foreign investors’ ownership of Type I providers (33%) and the Supply Demand Adjustment Clause[51].

Once the Telecommunications Law was approved, the state-owned monopoly, NTT, was privatized in 1985. In 1988, the company separated NTT DATA and in 1992, NTT DOCOMO, its mobile subsidiary, was spun off. In 1999, the operator was reorganized as a holding company of three operators: NTT East, NTT West and the long distance and international communications carrier NTT Communications. The five businesses, NTT DATA, NTT DOCOMO, NTT West, NTT East and NTT Communications comprise the NTT Group, in which the Japanese government remains a minority shareholder with approximately 33% of non-controlling shares.

[51] This condition provided the MIC with power to decide whether a company could enter the market based on a supply and/or demand analysis.

The second wave of reforms started in 1997, with the introduction of the *Designate Facility System Regulating System*[52]. The goal of this reform was to ensure access to the essential network facilities of dominant carriers. According to the 1984 Law, interconnection was based on agreements between the parties and only if an agreement was not reached did the MIC have the authority to intervene. Under the new system, the interconnection fees for the dominant providers would have to be calculated using a forward-looking long-run incremental cost methodology and be approved by the MIC. In 1998, the restriction to foreign ownership was abolished (except for NTT)[53]. In 1999, along with the reorganization of NTT, the market entry restrictions were reduced. Two years later, a Universal Service Fund was established.

Finally, in 2003 the TBL was amended aiming at the promotion of diverse deployment of business activities through substantial deregulation in the telecommunications market. The most important modifications were the elimination of the Type I and Type II providers' classification, and the abolishing of charge/tariff regulations on non- dominant providers[54].

4.2. Comprehensive long term planning:

In parallel with the NTT privatization and sector liberalization process, the Japanese government developed ICT strategies aimed at restructuring the industry. The initial push for strategic planning in the ICT sector started in 2001, when the government developed the first e-Japan Strategy (Mori, 2007). The strategy planning process enabled the formulation of annual priority policy programs focused on implementation (see figure 4).

[52] Under this system, the telecom operators who install the "designated facility", which is the facility access that is critical to competitors to provide any meaningful service in the market, is regulated strictly.
[53] In 1992 the NTT foreign ownership restriction was relaxed to 20% and in 2001 to 1/3.
[54] Additionally, as a mechanism to oversight competition, in 2004 the government announced the *Competition Review in the Telecommunications Business Field* report, which would be published in a yearly basis.

Figure 4. Japan ICT Strategies

Time	Strategies	Priority Policy Programs
2001	e-Japan Strategy (1/01)	e-Japan Priority Policy Program (3/01)
2002		e-Japan Priority Policy Program 2002 (6/02)
2003	e-Japan Strategy II (7/03)	e-Japan Priority Policy Program 2003 (8/03)
2004	e-Japan Strategy II Acceleration Package (2/04)	e-Japan Priority Policy Program 2004 (6/04)
2005	IT Policy Package (2/05)	
2006	New IT Reform Strategy (1/06)	e-Japan Priority Policy Program 2006 (7/06) u-Japan Promotion Program (9/06)
2007	New IT Reform Strategy Policy Package (4/07)	e-Japan Priority Policy Program 2007 (7/07)

In addition to the strategic plans, the government developed in 2006 an overarching strategic policy labeled u-Japan. The policy espoused three targets:

- Elimination of non-broadband served areas, establishing that by the end of 2010, broadband service should be available to 100% of the population, while high speed broadband should be available to 90% of the population.
- By the same year, 80% of the population should value ICT as a tool to address social needs
- Finally, in the same year, 80% of the population will be ICT literate in order to feel at ease accessing the internet and computer technologies

4.3. Industrial policies:

In parallel with the promotion of domestic ICT development, the MIC recognized the need to enhance Japan's international competitiveness in the ICT arena. To further enhance Japan's

position, the Ministry set up in 2007 the ICT International Competitiveness Enhancement Program aimed at promoting Japanese products and developing world markets through a collaboration of industry, academia and government.

This program has been actively endorsed by the ICT manufacturing sector. The development of ICT strategies has been constantly supported by large domestic high-technology companies, such as Canon, Mitsubishi, Nintendo, Panasonic, Sony and Toshiba (Kim, 2009).

4.4. Demand side policies:

The Japanese government considers that ICT adoption plays an important role in the competitiveness of enterprises. This is why it has developed two types of initiatives to foster ICT adoption, especially among SMEs. The first type is oriented to the creation of tax incentives and the second one to the provision of training.

In 2003 the government implemented a tax reform to introduce tax incentives designed to stimulate investment by companies in ICT assets and software. Firms investing in ICT solely for their own use have an option of either a 10 per cent credit on corporate taxes or a special depreciation equivalent to 50 per cent of the acquisition cost[55].

As a part of the SMEs Strategy Plan, the government created the IT Management Support Team, a public-private sector partnership network. It aims to encourage SMEs to voluntarily implement IT management to reform business management and improve productivity. The IT Management Support Team assists local SMEs by providing training, collecting and disseminating best practices and supporting collaboration with local communities.

4.5. Regulatory framework:

To complement the high-level policy approaches in the areas of sector liberalization, privatization and industrial planning, Japanese policymakers introduced a number of specific regulations in the areas of broadband services and wireless.

4.5.1. Broadband services regulation:

Following the original distinction between Type I and Type II carriers, Japanese regulators defined rules for a service-based competition model which could have served as a framework to develop broadband. Along those, in 2000, new competition policies comprising collocation

[55] The coverage of ICT assets by the scheme is large. The following types of assets potentially qualify, when acquiring for business use: large memory electronics calculators, digital copying equipment, facsimiles, IC card-using equipment, digital communication equipment, Internet telephone equipment, router switches, digital circuit connection systems, and software.

and unbundling rules were implemented to open up bottleneck facilities to other competitive carriers**.** Based on this decision, competitive providers to NTT were able to gain access at low cost to copper lines to the customer premise and metropolitan fiber connections between the incumbent's central offices. The net result of this policy was the growth of the unbundling industry and the drop of NTT's share of the retail ADSL market to 38% by March 2007[56]. Nevertheless, the impact of unbundling on broadband deployment was primarily limited to ADSL service over copper lines (see figure 5).

Figure 5. Japan: Market share of NTT East and West (3/2007)

Service	Market Share
Copper lines	99.9 %
Copper & fiber & CATV lines	92.5 %
FTTH	78.9 %
Fixed telephone revenue	90.6 %
ADSL revenue	38.0 %
FTTH Service revenue	69.0 %

Source: Taniwaki (2007)

In 2001 the Japanese telecommunications market entered into a major consolidation phase, leading to horizontal integration via convergence of transmission platforms around IP-based networks, combined with vertical integration across the four layers of the competition model. Among the transactions, this process comprised acquisitions by the KDDI group (Yozan, Powered.com, 3 Tu-ka companies, and the Tokyo Electric Power Company's FTTH business) and by Softbank (Vodafone and Japan Telecom, as well as Cable & Wireless IDC group). This process of consolidation led to the emergence of strong vertically-integrated providers, which triggered platform-based competition around fiber infrastructure. K-Opti.com (a subsidiary of the Kansai Electric Power Company), STNet (a subsidiary of the Shikoku Electric Power Company) and many large cable TV operators started deploying and operating fiber-based facilities in direct competition with NTT. As a result, facilities-based competition in fiber-enabled broadband is currently prevalent in all large metropolitan areas. This is facilitated by exogenous factors such as population density and the fact that aerial deployment of fiber on

[56] As of August 2007, 14,449 competitive telecom carriers existed (Taniwaki, 2007).

the last mile is permitted in Japan, which substantially reduces the cost of the overbuilt infrastructure.

As a consequence of this development, the Japanese government started deregulating prices and tariffs where facilities-based competition existed. In other areas, the regulator maintained line sharing and interconnection requirements, unbundling facilities to facilitate new entry, complemented with dispute resolution processes. Following this geographically segmented approach, the Japanese government is currently engaged in a transition from “ex-ante” to “ex-post” regulation. This evolution comprised the elimination of Type I and Type II carrier businesses, a drastic deregulation of prices and tariffs, and the introduction of a competitive review mechanism. This migration includes the opening of poles and ducts owned by NTT, EW and power companies, as well as opening the access of fiber optic networks installed by local governments to telecommunications carriers and the introduction of Fixed Wireless Access.

Along those lines, interconnection policy is being reviewed by reconsidering the open-up obligation and a review of the method for calculating interconnection charges. Interconnection with major suppliers is handled at the operator’s exchange. In addition, a competitive safeguard system to review bottleneck facilities is being considered. While unbundling on fiber has been stipulated, it has been less effective. In this case, the regulation stipulates the right to lease dark fiber at "future cost pricing" (Miura, 2009). It is apparent that fiber unbundling has not been an important causal factor in driving deployment or enabling new entrant activity (Berkman Center, 2009)[57].

Fiber optic deployment is considered to be a responsibility of the private sector. The role of the government is limited to easing the financial burden of the operators. Two types of incentives for deployment are provided. Loan systems with interest rates lower than the market rate are made available to any carrier with a fiber network installation plan. Tax deductions are assigned to carriers engaged in fiber deployment.

However, it would appear that the role of low-interest loans in stimulating fiber deployment has been exaggerated, at least in the case of NTT. According to Miura (2009), NTT borrowed from the government less than three percent of its total investment in fiber optics. Furthermore, the spread between the government subsidized loans and the market rate appeared to be quite small (approximately 0.2%). Nevertheless, it would seem that low-interest loans played a larger role in the deployment of municipal fiber networks.

[57] According to Miura (2009), less than 10% of NTT's own fiber network is leased to competitive carriers.

In addition to low-interest loans, the Japanese government has provided grants to promote local telecommunications infrastructure deployment focused on 1% of areas not served by any broadband network (MIC, 2009). The grants are provided through a universal service program primarily focused on subsidizing deployment of municipal networks.

4.5.2. Wireless services regulation:

NTT started providing mobile services in 1979 using a proprietary system. After the privatization of NTT and using the Supply/Demand Clause, the MIC did not allow the entry of competition in the mobile market until 1988. Initially its intention was to award only one license for a single competitor by orchestrating a consortium of major companies. As a result, Nihon Ido Tsushin (IDO) was created with major investments from Toyota, Tokyo Electric Power Company, and others. Later, one of the long distance telecommunications competitors, Daini Denden (DDI) and Astel, also entered into the cellular market.

Due to the model of command and control followed to award licenses (beauty contest), no operator had to incur financial hardship, and therefore ended assigning large amounts of investment to building infrastructure. The market entered into a consolidation cycle leading to a structure composed of three national players and a small carrier (see figure 6).

Figure 6. Japan: Wireless market structure (3Q09)

Players	Subscribers ('000)	Retail Market Share	Share of Net Adds	Population served	Share within the territory	ARPU (in $ US)
NTT Docomo	5 4,864	49.3%	37%	100%	49.3%	55.85
KDDI	3 0,996	27.8%	21%	100%	27.8%	57.49
Softbank Mobile (*)	2 0,956	18.8%	45%	100%	18.8%	41.37
Willcom	4 ,536	4.1 %	-4%	100%	4.1 %	---
Total	111,353	100%				53.48

(*) Acquired from Vodafone

Source: Merrill Lynch

Now, the government aims to increase the allocation of spectrum to facilitate the further development of mobile broadband by licensing new Broadband Wireless Access (BWA) systems in the 2.545-2.625 GHz band.

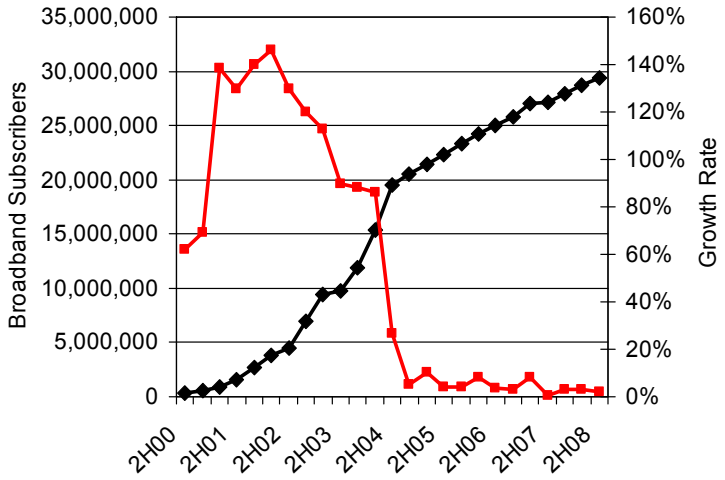
5. Resulting ICT Sector performance:

The combined effect of general ICT policies, as well as broadband and wireless specific regulation led to fast development of those two sectors.

5.1. Fixed broadband:

Broadband penetration in Japan has reached approximately 65 % of households. Service diffusion has significantly slowed in recent times indicating gradual saturation (figure 7).

Figure 7. Japan: Broadband adoption



Sources: Ministry of Internal Affairs and Communications; analysis by the author

Saturation is resulting both from a maturing broadband market (service coverage has reached 100 % of households) and a significant penetration of wireless broadband (as of 9/08, 89.3% of all wireless phones (104 million) were 3G) (see figure 8).

Figure 8. Japan: Household broadband coverage

Service	3/06	3/07	7/07	2010
Broadband	93.9 %	95.2 %	95.6 %	100 %
FTTH	79.7 %	83.5 %	84.1 %	90 %

Source: MIC

The vibrant broadband supply side is split between facilities-based telcos, cable TV operators and unbundlers (see figure 9).

Figure 9. Japan: Fixed Broadband Market (2Q08)

Type of player	Players	Subscribers (000)	Retail market share
Facilities-based telcos	NTT East	7,743	26 %
	NTT West	6,317	21 %
	Power utilities	1,334	5 %
	USEN	641	2 %
	KDDI	798	3 %
	Subtotal	16,833	57 %
Cable-TV (*)		3,956	13 %
Unbundlers	Softbank	4,277	15 %
	ACCA	1,093	4 %
	E Access	1,610	5 %
	Other	1,573	5 %
	Subtotal	8,553	29 %
TOTAL		29,342	

(*) Includes Jupiter Telecom (owned by Liberty Global)

Source: MIAC; Morgan Stanley; analysis by the author

Furthermore, technological innovation in broadband is extremely high. Fiber optics represent approximately 52% of telco lines and 45 % of all broadband accesses (see figure 10)

Figure 10. Japan: Broadband evolution (in '000 number of lines)

		9/06	12/06	3/07	6/07	9/07	12/07	3/08	6/08	9/08	12/08
Telecommunications	ADSL		14,236	14,013	13,794	13,483	13,133	12,711	12,290	11,966	11,594
	Fiber		7,940	8,804	9,700	10,507	11,329	12,153	13,082	13,756	14,417
	Total		22,176	22,817	23,494	23,990	24,462	24,864	25,372	25,722	26,011
Cable TV	Total		3,567	3,610	3,691	3,743	3,827	3,872	3,956	4,019	4,083
Fixed Wireless	Total		12	12	12	12	12	13	13	13	13
Total		25,040	25,755	26,439	27,199	27,746	28,302	27,749	29,341	29,755	30,107

(*) Powerline, satellite

Sources: MIC

As the figure indicates, the most dynamic growth platform is fiber, while cable has a limited no-growth presence and fixed wireless is practically non-existent. This would explain why the government is attempting to promote Wimax as a way to offer service in uncovered areas.

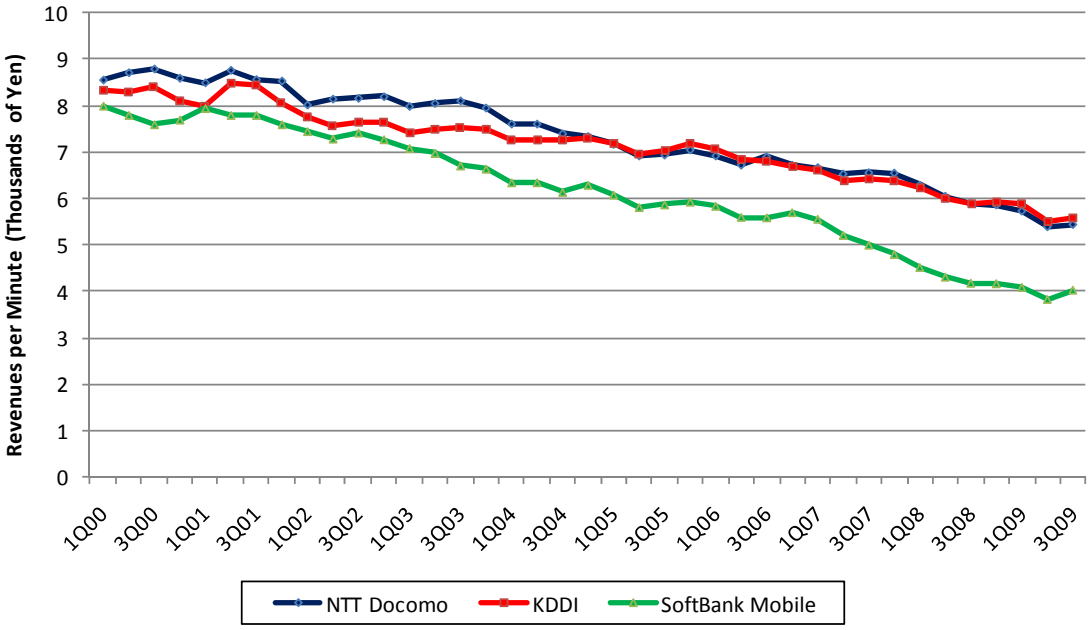
5.2. Wireless services:

Primarily driven by competition, Japan's wireless penetration has reached 89.4 % of population, while market penetration of 3G services has attained 83.9% of population. For the last decade, the market has shown a continuous drop in prices with only a brief period of stabilization after the introduction of 3G services[58] in 2002.

The introduction of mobile number portability (2007) seems to have increased the competitive pressures causing a strong fall in prices (see figure 11).

[58] Vodafone (Softbank mobile) did not introduce 3G services until 2003

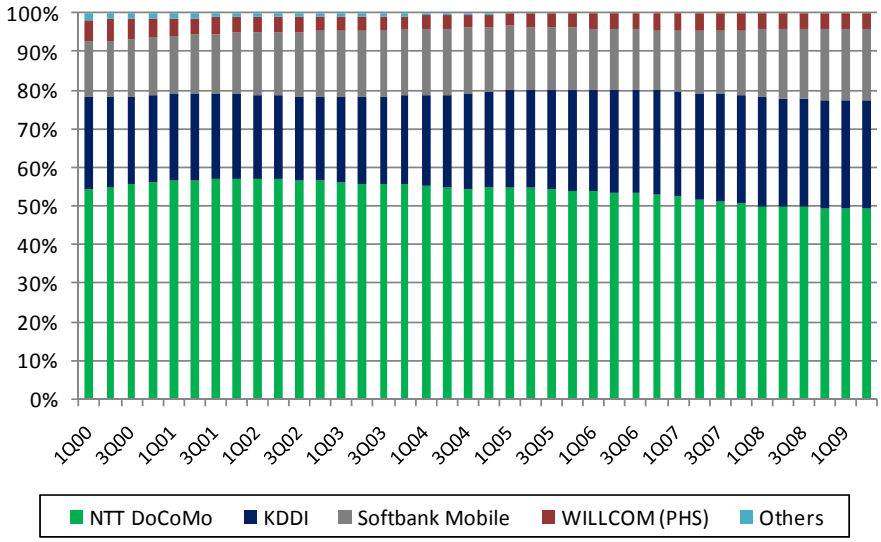
Figure 11. Japan: Wireless revenue per minute



Source: Merrill Lynch

During the last decade, operators have been cutting prices in order to retain market shares (see figure 12).

Figure 12. Japan: Wireless Market Shares



Source: Merrill Lynch

5.3. Content industries:

The Japanese mobile market sets the pace in terms of content delivery, with the global telecoms industry often looking towards the country in terms of what it can expect to achieve next. Early to adopt 3G and now with the majority of customers using 3G services, Japanese operators have a good understanding of what customers demand from their mobile services.

According to the MIC, the value of business carried out over Japan's mobile handsets reached US$107.6bn in 2007. Of this, the mobile content market represented almost US$ 40 bn. The government reported high-fidelity music as contributing the most to mobile content with US$10 bn.

For example, to increase its participation in the market, KDDI launched a music service called "Chaku Uta Full Plus," an offering that allows music to be downloaded at a bit rate speed of 320Kbps. One month prior to this, it had launched the "au BOX," an amusement box solely for mobile handsets that allows users to choose from 1.3mn songs and download video titles from a collection of 5,000 Hollywood movies. Another operator trying to enhance its participation in the content market is NTT DoCoMo. It has teamed up with Avex Entertainment to form Avex Broadcasting and Communications for the production and on-demand distribution of video content packaged for the mobile sector. Following this, it acquired a 35% stake in mobile video company, PacketVideo, at a cost of US$45.5mn in July 2009. KDDI, meanwhile, had previously (in June 2008) introduced the LISMO Video, allowing the operator to offer the delivery of both films and TV to either mobile handsets or PCs.

6. Conclusion:

The Japanese experience represents an example of a fine-tuned combination of top-down sector planning combined with the creation of a set of incentives to stimulate facilities-based competition. The results are extremely positive in terms of having promoted not only high adoption of information technologies but also a very high rate of innovation among suppliers. Fiber optics, wireless broadband, and content development are the three areas where Japan has captured a leadership position among industrialized nations.

To continue promoting the development of the ICT sector, the government is emphasizing training and adoption with the target the elimination of the digital divide. In addition, following the vision of ubiquitous technology deployment, Japanese policy makers are targeting the next stage of ICT development.

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Section IV: Policy and Development of ICT

Part C.5: The Impact of Platform-Based Competition and Industrial Policy Mix: Korea

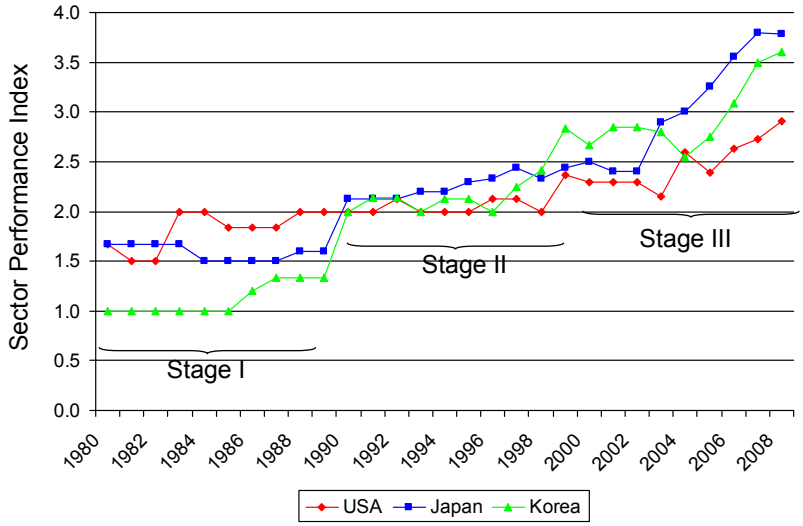
By Raul L. Katz (Columbia University)

1. Introduction:

The Korean ICT sector is one of the world's top performers in terms of telecommunications service adoption, quality, productivity, and innovation. Korea's top performance is based on having achieved the highest household penetration of broadband in the world (91 %), near universal wireless adoption (94 %)[59], and the second highest diffusion of fiber optics in the telecommunications local loop among OECD countries (46 % of broadband accesses)[60].

A comparative analysis of the sector performance of Korea against the United States and Japan since the 1980s displays the success of a country that in the mid-1950s had a rural economy in ruins[61] and, through a set of policy initiatives, has propelled itself to the forefront of the information society (see figure 1):

Figure 1. Korea vs. Japan and the US: Evolution of ICT Sector Performance[62]



Source: ITU; analysis by the author

A comparative analysis of telecom sector performance of the U.S., Japan and Korea between 1980 and 2008 indicates three clearly defined stages. Between 1980 and 1990, we can observe that Korea underperformed both the U.S. and Japan. For example, in 1980, Korea's penetration

[59] Source: International telecommunications Union.
[60] Source: OECD Broadband Portal, June 2009.
[61] In the mid-1960s, Korea's GDP was comparable to that of African countries like Senegal and Mozambique. In 1960, according to ITU statistics, the Korean telephone penetration was 0.36 lines per 100 inhabitants.
[62] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.

of fixed telephony was only 7.1 %, per population while the U.S. was 40.8 % and Japan, 34.2 %. Between 1990 and 2000, the situation changes, and the three countries display comparable performance levels. In fact, by 1990, penetration of fixed telephony had skyrocketed to 31 %, while by 2000, Korea's wireless penetration had surpassed the U.S. Finally, starting in 2000 throughout 2008, Japan and Korea move ahead of the U.S., displaying substantial over-performance in almost all ICT sector metrics.

Several policy variables explain this change in leadership position, although in the cases of Japan and Korea, an industrial policy guided by a vision of the country's technological future appears to be the guiding factor. The focus of this case study is to assess the policies that allowed Korea to gain its superior position. At a summary level, four public policies explain Korea's performance:

- Industrial policy aimed at building an ICT-export base power;
- Regulatory framework focused on privatizing and opening the telecommunications sector to competition, while building sector sustainability;
- Integrated long-term planning ; and
- Collaboration between the public and private sectors.

These four policies were implemented in the context of a vision and strategy formulated early on by the Korean government. The following case study reviews the specific policies and planning efforts deployed by the government, and the results achieved.

2. Context:

The Korean ICT sector is, at present, the most advanced in the industrialized world (see figure 2).

Figure 2. Indicators of Korean ICT sector performance (2008)

	Population Penetration			Household Penetration		
	Korea	EU	OECD	Korea	EU	OECD
Fixed Line Adoption	44.1 %	46 %	43 %	85%	70 %	72.%
Wireless Subscriber penetration	94.2 %	83 %	99 %			
Broadband penetration	32.8 %	23 %	22 %	91.3%	49 %	60%
Personal Computers	60.6%	46 %	54 %			

Sources: ITU (2009); OECD Broadband portal; Euromonitor International

Fixed-line telecommunications have reached an adoption level of 44 % per population, while wireless telephony exhibits 94 % penetration. Broadband service, which was introduced in 1998, reached an adoption level of 91 % per household in 2008.

One of the striking features of this performance is that, while being an OECD country, Korea remains at the lower end of high-income industrialized countries, and it underwent an acute financial crisis in the late 1990s which could have had a negative effect on technology diffusion. When compared with other developed countries of higher GDP per capita, Korea ranks higher than the latter in terms of ICT sector performance (see figure 3).

Figure 3. Economic Development versus ICT sector performance (2008)

Country	GDP per capita	ICT Performance Index[63]
Denmark	62,579	3.44
Sweden	52,305	3.43
United States	46,194	3.13
Canada	45,278	2.57
United Kingdom	43,472	3.12
France	41,508	2.71
Germany	40,182	2.86
Korea	19,115	3.57

Sources: World Bank; analysis by the author

Regarding other benchmark metrics, Korea ranks second in the Digital Opportunity Index (ITU, 2009), second on the Information Society Index (IDC, 2009), eleventh on the Network Readiness Index (World Economic Forum, 2009), and tenth in the Global Connectivity Scorecard (LECG, 2009).

At the core of the Korean success we can identify a mix of active government intervention with competitive private-led markets. While some of the elements of this formula can be identified in Japan's case throughout the past thirty years and at specific times in the sector history in some advanced nations (e.g. Sweden in the late 90s), the Korean example is quite peculiar in the sense that it posits a fine-tuned system of government holistic planning and ad-hoc focused intervention, coupled with a fairly innovative and competitive private sector. The following section will outline the policy objectives and tools that were instrumental in achieving this leading position. After reviewing the policy domain, we will examine how it has played out in the development of both the mobile and broadband sectors.

3. Policy objectives:

Korea's initial push for building a world-class ICT sector was triggered by a shift in industrial policy emphasis that took place in the late 1970s. Before then, Korean economic growth

[63] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.

focused on developing heavy industries, such as machinery, shipbuilding and chemicals. In the 1980s, however, the government started placing emphasis on the development of information technology intensive industries like semi-conductors, electronics, and computers (Kim, 2010). Several factors drove this change in emphasis. On the domestic front, the development of large industrial firms emphasized the need to make available a state-of the-art information technology infrastructure. In addition, economic growth combined with an underdeveloped telecommunications network had created a large amount of unmet demand. With 21% of households served, the waiting list for telephone service amounted to more than 600,000 lines, with provisioning intervals extending to several years (Yoo, 2008). Along these lines, developing a program that met the pent-up demand had broad public support, which appeared to be critical at the time[64].

On the international front, Korean policy makers determined that meeting demand in the domestic front and leveraging the industrial power of big conglomerates could allow the country to build an export base in electronics, IT and communications. Initially, however, objectives were articulated around meeting internal demand for an upgraded telecommunications infrastructure and entering the electronics arena. Over time, the guiding principle for the formulation of policies evolved toward "building the information society". Based on the overarching goal of developing an advanced information society, Korea formulated several successive master plans, which comprised both supply and demand-side policies.

4. Review of policy approach and tools:

4.1. Comprehensive long term planning:

The initial push for long term planning in the ICT sector started in 1982,when the government designated telecommunications as a priority area in the Fifth Five-Year Socio-Economic development Plan (1982-6) (Yoo, 2008). The goal articulated at the time was to achieve universal deployment of fixed line services, and to fund the development of a domestically produced digital switching system, with the state-owned monopoly telecommunications company acting as its anchor customer. Interestingly enough, the pattern of funding domestic technology deployment as a way to develop an industry will represent Korea's common approach to ICT sector development, whereby incubation of an export-oriented industry is linked to funding adoption of its products in the domestic market.

[64] Yoo (2008) points out that "questions about political legitimacy raised by the manner in which President Chun Do-Hwan came to power added to the government's determination to achieve prompt and tangible economic progress".

The first national ICT-focused plan was formulated in 1987 for an eight-year period. Starting in 1995, the government began preparing five-year plans that could be updated in case the environmental conditions changed relative to what was assumed in the course of the planning process[65]. Each plan tends to have a dominant center of gravity in terms of objectives (see figure 4)

Figure 4. Korean ICT Plans

Time Horizon	Plan	Key objective
1987-1996	National Information System	First national plan; "settlement after investment"
1995-2005	Information Infrastructure Initiative	Development of national backbone
1996-2000	First National Informatization Promotion Plan	Reach world class ICT performance levels by 2010
1999-2002	Cyber Korea 21	Build a knowledge-based society
2002-2006	e-Korea Vision 2006	Become a global leader
2003-2007	Broadband IT Korea Vision 2007	Development of broadband leadership
2006-2015	u-Korea Master Plan	Broadband convergence and ubiquitous networks

A significant feature of the Korean ICT government-sponsored planning process remains its holistic characteristic (Kim, 2010). Master plans are contextualized as tools for facilitating the transition into an advanced information society. This implied that planning axes included not only network infrastructure but also addressed services, applications and demand promotion policies. This last point represents a critical difference with the ICT sector development processes in other advanced economies. Planning efforts in other nations tend to have a heavy focus on network deployment and, while recognizing the positive spill-overs that networks will play on other sectors, they leave promotional efforts in these related

[65] As it occurred in 1990, as a result of the Asian crisis.

components of the ICT eco-system to market forces (a process that could be labeled as "build it and they will come"). Contrary to this philosophy, Korean policy makers tend, through their planning tools, to address all the components of the ICT eco-system in an inter-connected fashion, generating incentives in the areas of applications and services to follow through the build-up of networks.

Similarly, Korean planners recognized early on that addressing the digital divide required not only deploying networks but also dealing with the demand gap: those individuals and businesses that could adopt ICT platforms but would not do it either for lack of economic resources, technical training or cultural factors (Katz, 2009). Thus, all plans have a heavy demand promotion component.

4.2. Industrial policies:

A key policy objective of all Korean master plans has been the articulation of industrial policies such as R&D promotion and the provision of seed capital for infrastructure deployment.

The role of seed capital investment has been critical in the development of broadband services. In 1995, the government launched the Korea Information Infrastructure project in which it invested $900 million for "the construction of a national high speed backbone, the development of ICT applications and promotion of R&D and IT-related pilot projects" (Kim et al., 2010). The project comprised the creation of public-private partnerships, supported network rollout through the cyber building certification program, and funded an information promotion fund. The fund, originally established in 1993, has as its primary purposes the support of ICT-related R&D, the development and diffusion of industry standards, training of ICT resources, the promotion of e-Government applications and the stimulation of deployment of broadband networks. The fund benefits also from private sector contributions through spectrum licensing fees, a percentage of revenues from operators and interest-earning loans. As such, one of the fund's primary objectives is to reinvest profits of the ICT sector in the sector itself.

In terms of industrial policy objectives, the government has been quite directive in outlining frameworks and goals. Three plans have been developed with an objective to develop broadband infrastructure. The first one, labeled Korean Information Infrastructure, was enacted in 1995 and focused on the deployment of ATM, ADSL and cable modem technologies. The second, the IT 839 Strategy and Broadband Convergence policy focused on the deployment of VDSL, FTTB/H. WiBRO, W-CDMA, HSDPA, with the objective of raising average broadband download speeds to over 50 Mbps. As mentioned above regarding the holistic nature of plans, the IT389 strategy is much more than an infrastructure deployment

plan. The plan defines deployment and adoption objectives for eight services, nine products and three advanced infrastructures (see figure 5)

Figure 5. Interrelated objectives and workstreams for the IT 839 strategy

Domain	Components	Government responsibility	Private sector responsibility
Products	• Digital TV • Residential broadband • Next generation wireless network • Next generation PCs • Digital content • Telematics • Robotics • Next generation mobile communications	• Standardization • Technological support • Development of public pilot projects	Service development
Services	• Home networking • Telematics • VoIP • Terrestrial digital TV • W-CDMA • RIFD • WiBro	• Frequency distribution • Licensing of operators • Regulatory reform • Preserve competition	Service deployment
Infrastructure	• Broadband convergence network • Ubiquitous service network • Next generation Internet protocol	• Standardization • Market development • Manage an investment fund	• Technology development • Pilot project development

Source: IT 839, MIC.

It is important to notice the active role played by the government in areas ranging from the setting of technological standards to the investment in research and development. These add to the more conventional regulatory responsibilities such as managing the frequency allocation process and the definition of a competition model.

The third plan, Ultra Broadband convergence network, focused on the development of a convergent network supported by fiber optics, W-CDMA, HSDPA and WiBro, and delivering a target of 100 Mbps to 1 Gbps download speeds. Among the objectives mentioned in the plan, the broadband convergence network should reach 20 million subscribers by 2010, while the

soft infraware (DEFINE OR EXPLAIN WHAT INFRAWARE IS) will supply a technological platform aimed at integrating all services in the context of true convergent delivery. As a result, the Broadband Convergence Network (BcN) would integrate wireline and wireless services with all content distribution industries.

4.3. Regulatory framework:

4.3.1. Broadband services regulation:

Korea took its first steps to liberalize its telecommunications sector in the late 1980s, when it allowed the entry of a second provider of international telecommunications services. This led to the licensing of Dacom and Hanaro as competitors to the fixed line incumbent, Korea Telecom. Since then the regulatory framework has evolved toward liberalizing all wireline services.

The ruling for licensing telecommunication operators, enacted in 1997, was confirmation of the trend to promote sector competition. It differentiated three categories of firms, each one with different licensing requirements (see figure 6).

Figure 6. Korea: Licensing conditions for telecommunications operators

Category	Description	Types of services	Licensing conditions
Infrastructure operators	Owns a network and offers services on its own network	• Wireline • Wireless • Leased lines	Authorization
Special services operators	Does not own infrastructure and provide services based on the infrastructure of other operators	• VoIP • Call back • Voice telephony reselling	Registration
Value added services operators	Does not own infrastructure, restricting its service offering to VAS	• Internet Service Providers	Notification

Source: Ministry of Information and Communication

The differentiation of service providers was similar to that utilized by the Japanese regulatory agency in its characterization of type 1 and 2 operators. Furthermore, the difference between infrastructure and non-infrastructure operators implicitly opened the way to the introduction of a service-based competition model. In fact, in 1997 broadband service was designated as a value-added service, allowing unlimited entry.

However, broadband initially developed in Korea not through unbundling of access (service-based competition) but rather through platform-based competition. Broadband service was introduced in Korea in 1998 when Thrunet, a cable TV operator, launched service. Subsequently, other operators (Dreamline, SKT y Onse) entered the market by leasing infrastructure from other cable TV operators. In 1999, Hanaro, an alternative carrier competing with Korea Telecom in local telephony services, entered the broadband market through ADSL and cable modem platforms. This led the incumbent to respond by replacing its original ISDN platform with ADSL.

In 2002, after platform competition had developed and at the same time that the privatization of Korea Telecom was concluded, the government introduced legislation aimed at unbundling the local loop to lower the costs of new entrants. This led to the entry of numerous competitors, triggering hypercompetition, which resulted in price wars and product commoditization. These competitive dynamics led three of the top four market share leaders to face financial and operating shortfalls. Thrunet and Onse filed for bankruptcy in 2003[66], while Hanaro was actively searching for alternative investment sources. At this time, the government intervened actively in the process leading to consolidation of players in a small number of vertically-integrated operators. This process was facilitated by the interlocking share holdings of *chaebols* operating in the ICT sector (see below).

With consolidation, the government had to intervene to maintain adequate levels of competition in a concentrated market structure. In 2005, the regulator introduced pricing regulation and recategorized broadband as facilities-based service. In July 2007, the government approved the law allowing competition based on bundled services and in November of the same year the law allowing content distribution by telecommunications operators. Finally, in 2008, the government allowed VoIP number portability.

The easing of bundling services in 2007 led to further market consolidation when Hanaro and SK Telecom merged, leading to the emergence of the second infrastructure operator present in all industry sectors. The resulting market structure was fairly consolidated with Korea

[66] Part of the difficulties of cable TV operators were originated in the regulatory framework imposed on them by the government, which prevented their consolidation of a national player capable of competing effectively with KT or Hanaro.

Telecom controlling 45%, Hanaro Telecom, 26% and LG (comprised of Telecom, Dacom, and Powercom) 10%. The remaining 19% was controlled by a fragmented set of providers[67].

As it can be observed, the process of broadband regulation in Korea went through three clearly defined stages: 1) infrastructure-based competition led by the entry of cable TV operators, 2) unlimited entry-based unbundling rules which led to value destruction as a result of hypercompetition, and 3) market consolidation in a few vertically-integrated players. Through these three phases, the government adapted its regulatory framework, evolving from service-based competition to facilities-based combined with pragmatic, focused interventions.

4.3.2. Wireless services regulation:

Wireless services were launched in Korea in 1984 by a single operator, Korea Mobile Telecom, owned by Korea Telecom. Prompted by trade negotiations, the government decided to open the wireless market to competition. In 1994, the government forced Korea telecom to sell its wireless unit to the Sunkyung group, which renamed it SK Telecom after the acquisition. In 1996, the government assigned a second license to Shinsegi Telecom (STI), a CDMA-based operator in which U.S. companies Airtouch (now part of Verizon), SBC (now part of ATT) and Qualcomm held shares. The entry of U.S. companies in the Korean market was the result of bilateral trade negotiations between the U.S. and Korean governments, leading to the opening of the telecom market to FDI[68].

In parallel with the entry of Shinsegi, the government allowed three so-called PCS providers to enter the market. Liberalization allowed the fixed line incumbent and other *chaebols* to enter the market as Korea Telecom Freetel, LG Telecom and Hansol PCS[69]. Government intervention in the assignment of licenses was quite strong given that selection followed a "beauty contest" where consortium ownership of the applicant was a key criterion (Yoo, 2008). Following the entry of three more players, wireless penetration grew dramatically reaching 45% by 1999. Price competition did not materialize except in heavy handset subsidies implemented by new PCS entrants. The level of subsidies was such (reaching $200/handset) that the government expressed concern that they could seriously impact the

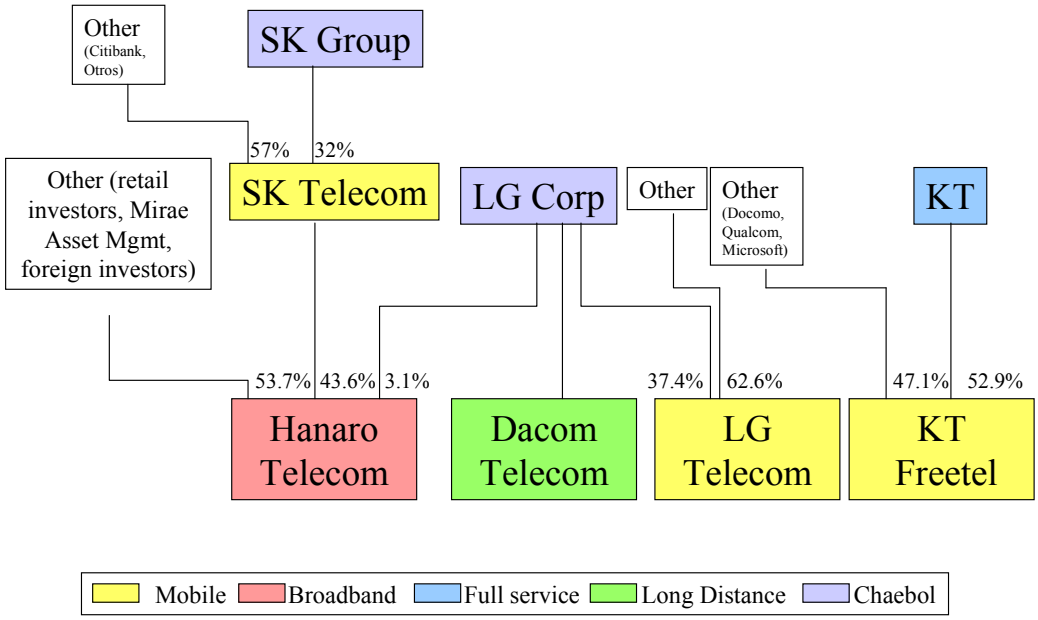
[67] Source: Korea Telecom (2008).
[68] The ongoing trade deficits and the approach that Korea was following in terms of protecting its domestic market from foreign entry led to a lengthy set of negotiations resulting in a comprehensive bilateral agreement signed in 1992 allowing foreign firms to enter the market. The pressure to stimulate foreign investment accelerated after the Asian financial crisis of 1997, which led the government to raise the percentage of foreign ownership of a telecommunications operator to 49%.
[69] In addition lo local Korean capital, each new entrant had a foreign partner: KT Freetel (Callahan), LG Telecom (BT), Hansol PCS (Bell Canada, AIG).

financial sustainability of several operators. For example, one operator's debt as percent of capital reached at the time 1108 %. At this point, sensing an impending sector crisis, the government intervened and capped the subsidy to $125 per handset.

With limited room for price competition, and an overwhelming commoditization of offerings, the market entered a consolidation cycle. Hansol, which had been fully acquired by Bell Canada and AIG in 1998, was sold to Korea Telecom Freetel in 2001, while Shinsegi was acquired by SK Telecom in 2002. Later, Korea Telecom, now branded KT, integrated Freetel into its organization.

The resulting consolidation yielded a triopoly in the wireless market, a duopoly in wireline and a somewhat more fragmented structure in broadband. The resulting industry structure was as follows (see figure 7).

Figure 7. Capital structure of key ICT players



Source: Katz (2008)

That was not the end of government intervention. In fact, at this point the government was concerned that a concentrated industry structure was going to limit competition and welfare effects. Concerned about interlocking stock holdings which could act as a limiting effect on competitive dynamics, the government forced SK telecom and KT to eliminate their cross-ownership position.

With the stability generated by sector consolidation, in order to promote competition, the government gradually introduced mobile number portability. In addition, the government estimated that the regulation of handset subsidies was no longer necessary and removed the cap. This measure did not have any negative impact since competition materialized this time around product differentiation driven by mobile broadband[70]. The momentum for the introduction of mobile broadband services started in 2000-1 when licenses for 3G services were awarded. Since then, W-CDMA services have been offered by SKT and KT, and in 2006 HSDPA services were introduced.

4.4. Demand side policies:

A differentiating factor in the Korean experience is the early emphasis on the implementation of demand-side policies. While these were not particularly critical at the time of diffusion of a fixed telephony network, issues such as computer literacy and training of management and employees of small and medium enterprises became more important with the development of broadband.

Kim et al. (2010) enumerate four initiatives aimed at addressing demand-side issues in the broadband arena:

- Demand aggregation among government entities to create "anchor tenants" for broadband service[71];
- Promotion of e-commerce (in payment for government services) in order to have a stimulus effect on business adoption of broadband;
- Development of e-government services such as electronic submission of tax returns, an e-procurement service for SMEs selling goods and services to the government and platforms for tele-commuting; and
- Implementation of digital literacy programs comprising subsidies for acquiring PCs, and online education programs targeted to the elderly and disabled.

In addition to government sponsored initiatives, the *chaebols* played an important role in stimulating adoption among small and medium enterprises. The large conglomerates developed programs that forced their SME suppliers to adopt the necessary eCommerce and broadband platforms if they wanted to continue being part of the supply chain of large firms.

[70] Each company owns a license to deploy wireless 3G services.

[71] This consists in aggregating demand from all government entities requiring broadband services (e.g. administration, public schools, hospitals, etc.) and assigning them the primary role of anchor tenants that ensure that investment in broadband networks can rapidly achieve a breakeven point.

5. Results:

In addition to building an industrial base for promoting high-technology exports, the key success of the Korean experience is the acceleration of the diffusion curves of platforms such as mobile and broadband services.

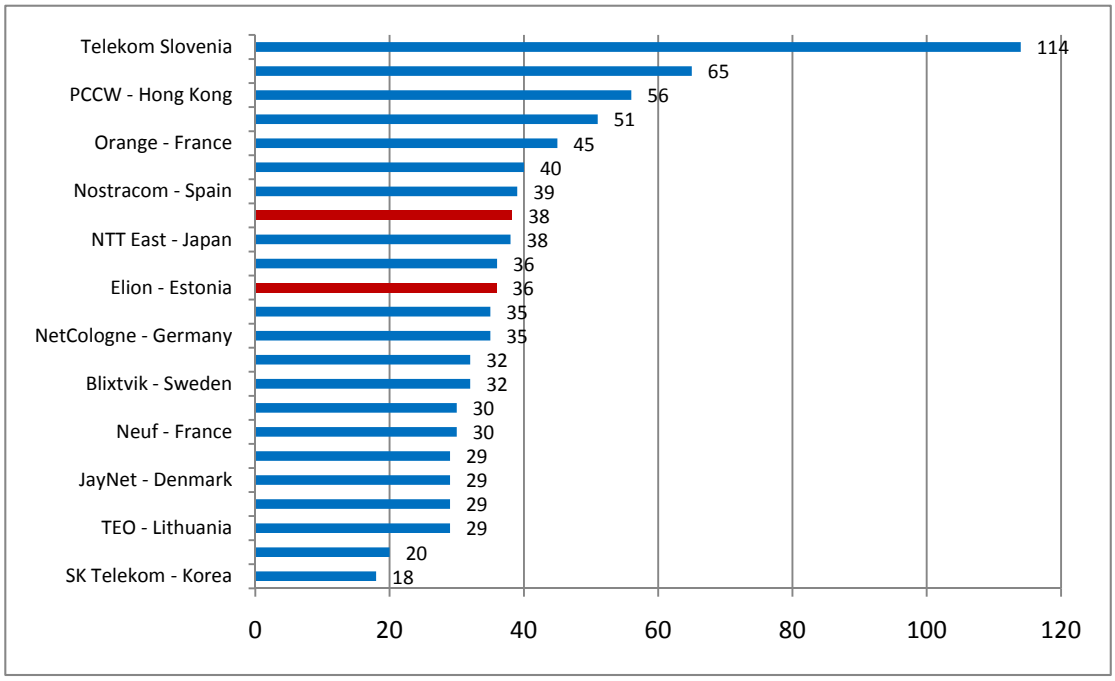
5.1. Fixed broadband:

By June 2009 fixed broadband penetration was 32 % of population and 94% of households. In addition to the factors mentioned above which drove this result, one should mention that Korea's geography is particularly favorable to broadband facilities based competition. With 80% of people living in cities, and 40% in apartments, the topography was quite amenable to the emergence of platform-based competition[72]. In addition, government seed funding was critical in allowing new entrants access to capital to build out their networks. Furthermore, the funding was made conditional to the deployment of broadband in less dense areas, thus preventing "cream-skimming".

Since 2005, the country has witnessed rapid deployment of fiber access in the local loop. The roll-out has resulted by the end of 2008, in 6.6 million fiber-based subscribers, or 46% of all broadband accesses. Furthermore, pricing of 100 Mb service is the lowest among industrialized nations (see figure 8).

[72] This allowed Hanaro to launch DSL services without depending on KT to acquire loop access. Thus, unbundling local loops was not a critical factor enabling competitive entry (Yoo, 2008).

Figure 8: 100MB FTTH Pricing (in euros per month)

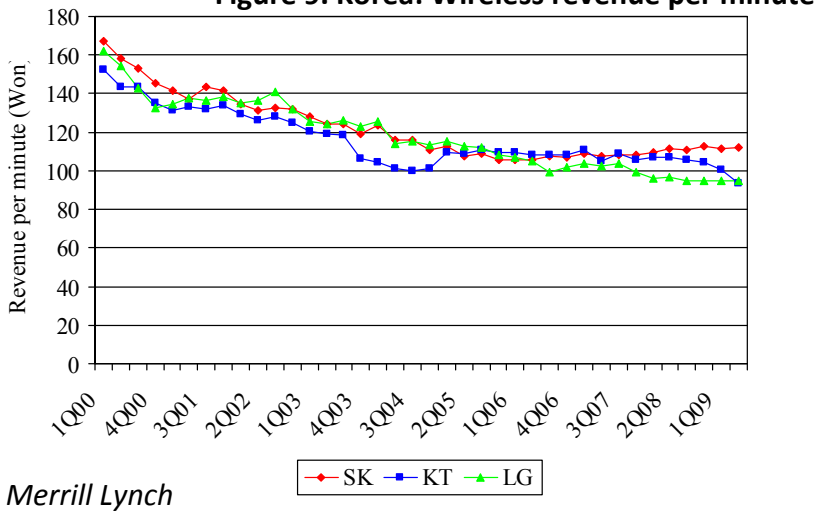


Source: Tariff Consultancy (2009)

5.2. Wireless services:

Primarily driven by competition, Korea's wireless penetration has reached 94.2 % of population, while market penetration of 3G services has attained 77% of population. On the other hand, prices have not dropped as much as what has been seen in other industrialized country markets. In fact, since 2004, prices have remained fairly stable (around 100 won per minute) (see figure 9).

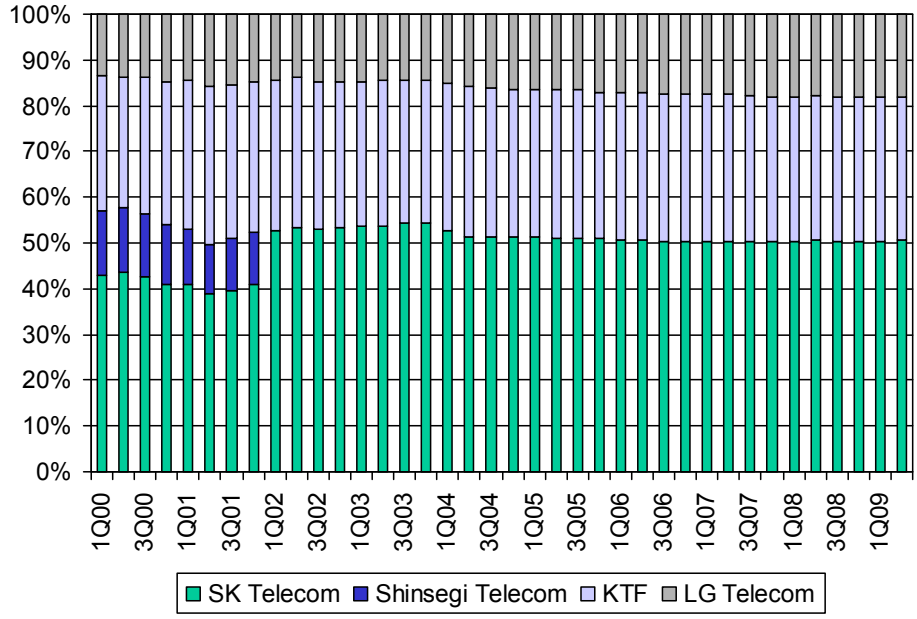
Figure 9. Korea: Wireless revenue per minute



Source: Merrill Lynch

Many analysts have linked the lack of price decline in wireless with a triopoly industry structure, exhibiting fairly consistent shares across players (see figure 10).

Figure 10. Korea: Wireless Market Shares



Source: Merrill Lynch

5.3. Content industries:

As mentioned above, Korea's policies regarding broadband development were always focused on the development of an applications and services sector both benefiting and acting as a stimulus of infrastructure usage. As a result, the development of broadband acted as a stimulus for the creation of a content industry. Among the newly-created industries, Korea counts an $8.3-billion online gaming, a $ 3.4-billion domestic content industry, as a well as a home-grown internet search sector (Kim et al, 2010).

6. Conclusion:

The Korean case study indicates a very specific success model of ICT development, depicting a mix of private competitive markets and government intervention, embodied in a set of rigorous development of sector master plans, seed funding and informal intervention in mergers and acquisition dynamics. How unique is this model?

First, the generation of ICT master plans has been a long-standing feature of many Asian countries. Beyond Japan (which is reviewed in its specific case), other Asian and European

countries have been implementing either ICT sector plans or dealing with ICT in the context of general economic development plans[73].

The second feature of the Korean case is active government intervention in shaping industry structure, either with the purpose of creating national champions, fostering export-led industries, or addressing sector sustainability. A review of cases of ICT sector development indicates that the practice of government intervention in shaping industry structure is fairly pervasive across the industrialized world, except that the Korean government appears to be more aggressive and proactive than its peers[74]. At several points in the development of the sector, the government intervened in the market "in a focused and strategic way" shaping industry structure. The government often negotiated with the giant conglomerates their participation in the telecommunications sector. For example, in the last tranche of privatization of Korea Telecom, the government agreed to allow SK Telecom to acquire 11.3% of shares, while LG acquired 2.3%. Similarly, as mentioned above, the government fostered the consolidation of wireless players and broadband service providers at times of financial crisis.

Finally, the presence of *chaebols,* as giant cross-industry conglomerates with a presence in the ICT sector, represents a highly specific feature of the Korean industry context. In fact, the dynamics of sector restructuring are driven by the dialectic relationship between the government and the *chaebols*. The principle of managed competition is a philosophy of market development implemented in Korea for both the broadband and wireless sector (Yoo et al, 2005). According to this, in the first stage of market formation, the government, in collaboration with the *chaebols,* defines the regulatory norms and standards that will serve as a basis for service deployment. The second stage is characterized by the unrestricted entry of numerous operators and intense competition. That was the period between 2001 and 2003 for the broadband industry and 1997 and 2002 for the wireless industry. The second phase ends with consolidation, in which the government positions itself as the facilitator of the mergers. In the third phase, denominated regulated competition, the government focuses on the formulation of a regulatory framework that prevents market failures and abuse of market power. This new framework comprises the enactment of generic tools such as price controls and quality of service monitoring, as well as sector specific such as the handset subsidy cancellation in wireless, mobile number portability and incumbent tariff approval processes.

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[73] See the example of Malaysia, which has been putting an emphasis on ICT development for ten development plans, or in Europe, the case of Sweden (treated in another case study) and Finland.

[74] When the German Bundesrat approves regulatory holidays for the incumbent telecommunications carrier's obligation to wholesale its fiber infrastructure, it is implicitly making a decision that supports Deutsche Telekom, thereby buttressing its competitive position in the German and worldwide telecommunications sector.

In sum, what makes Korea unique is the combination of these three features (integrated planning, government intervention in shaping industry structure, and the presence of conglomerates). This raises a second question: To what extent can the Korean experience and practices be replicated?

The practice of ICT national planning appears to be quite common across the developed and developing world[75]. Two other planning practices, however, are very specific to Korea's model. The first is discipline in follow-up. Each plan is assessed in terms of its results at the end of the planning horizon and the results of the assessment are fed back in the formulation of the next iteration. In that sense, ICT planning in Korea is not a political tool subject to the vagaries of the political electoral cycle. It is the embodiment of state policies that capture a strategic vision, which in itself represents a consensus of all societal forces in the country.

The second practice, which is very specific to the Korean context, is the leadership displayed by the executive branch in managing the implementation of the plan. It is a common practice in Korea not only to name an "ICT Czar" but also guarantee this official access to the country's president on a regular basis. This places responsibility of steering the development of the sector squarely in the hands of the president. This situation, being fairly idiosyncratic to Korean's business culture, appears to be difficult to extrapolate as a best practice to other countries[76].

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[75] In Latin America alone, we count 15 countries which have developed ICT Master Plans (also labeled Digital Agendas or Connectivity Plans).

[76] Nevertheless, it is worth mention the role of the Prime Minister played in Finland vis-à-vis the development and implementation of this country's ICT strategy.

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Section IV: Policy and Development of ICT

Part C.6: Promoting ICT Diffusion Through Managed Competition: Mexico

By Raul L. Katz (Columbia University)

1. Introduction:

Since the privatization of Telmex, the Mexican telecommunications sector has been consistently improving its performance in terms of service adoption, pricing and range of offerings. However, while Mexico has undergone privatization of the incumbent and opening of the sector to competition, the peculiar characteristics of the Mexican liberalization process have influenced the pace at which sector performance has improved. While the privatization process has been undeniably successful, the process of sector liberalization has been greatly influenced by three specific factors:

- A regulatory agency perceived, at least until recently, to follow a strategy aimed at protecting the incumbent rather than promoting competition
- Limited transparency in the management of regulatory matters
- An investment law restricting the investment of foreign capital in Mexican wireline operators

While the first two factors have been undergoing changes in the last few years, the investment law has not been modified as of yet. The purpose of this case study is to determine to what extent the referenced factors have influenced the performance of the ICT sector. First, the process leading to the privatization of Telmex will be reviewed. Secondly, a series of regulatory decisions resulting in the emergence of a managed competitive environment (as opposed to free-competition) will be studied. Thirdly, the resulting market structure will be analyzed to determine the level of competition. Finally, we will assess the results regarding sector performance.

2. The privatization of Telmex:

In the first half of the 1980s Latin America was affected by one of the worst economic crises to ever confront the region. Mexico was no exception to this state of affairs. Partly triggered by this situation, Mexico joined the GATT in August 1986, leading to a shift of the import substitution industrialization precepts of the 1970s in favor of an open economy based on free trade as a strategy to resume growth. In this context, Carlos Salinas de Gortari, who assumed the presidency of the country in 1988, established an agenda to restructure the Mexican economy. The flagship of this vision was the privatization of one of the most profitable companies in Mexico, Telefonos de Mexico (TELMEX).

Until then, the state-owned monopoly had been managed under a cross-subsidy structure aimed at redistributing benefits to lower-income groups by maintaining low prices in local residential services and high prices in long-distance services. Despite the cross-subsidy structure, Telmex generated large profits that were used to fund other government projects

instead of the company's expansion plans. As a result, the sector was considerably underperforming. Wireline telephony penetration in 1980 was 3.9 %, and the waiting list for a fixed line amounted to 408,000 lines.

Once the privatization strategy was approved, the government implemented action plans aimed at achieving three objectives: first, render the company attractive for investors; second, achieve support for the transaction from the most important local economic groups, and, third, reach an agreement with the unions in order to provide the buyer with some leverage over the labor force. The first stage of the privatization strategy demanded a tariff rebalance. It was in this spirit that local tariffs were increased by 186 %, although prices for long distance calls suffered little reduction. Under the second stage, the government agreed to follow the demands of Mexican economic conglomerates: first, the company would not be divided in parts (e.g. long distance and local exchange, as in the case of ATT's divestiture) to be sold, and second, only Mexican citizens or corporations would be able to participate in the auction[77]. Finally, regarding the third action plan, the unions were assured that lay-offs would be kept at a minimum and they were offered shares of the privatized company.

The joint venture composed of the Mexican financial conglomerate Grupo Carso, and two foreign telephone operators, Southwestern Bell and France Cable et Radio (a subsidiary of France Telecom Inc.), won the privatization auction. The privatized company had to be regulated by the Ministry of Communications under the precepts established in the *Reglamento de Telecomunicaciones* of 1990 and by Telmex's franchise license. The most important conditions included in these documents were:

- Six-year monopoly grace period after privatization, prior to opening the long-distance telephony market to competition in 1996;
- The ownership of a public telephone network could be granted only to a Mexican citizen or association and entailed a temporary license to build and operate a network infrastructure in order to sell services, which in the case of telephony was considered a public service;
- A commitment to grow access lines by 12% annually from 1989 to 1992;
- A 60% expansion of the long-distance infrastructure, including digitalization of 65% of the nation's existing lines as well as deployment of additional digital networking, had to be provided;
- Telmex would be regulated by a price cap formula, which would be revised every four years pursuant to incremental costs;
- The company was to be taxed at an effective tax rate of 29 % of revenues with the added incentive that the company could offset 65 % of that tax rate against investments; and
- Telmex was obliged to interconnect with new entrants to the market.

[77] First, for a corporation to be considered Mexican, at least 51% had to be owned by Mexican capital. Later in the process, because no Mexican company participating in the auction met this condition, this was changed for the condition that it had to have a majority of voting shares.

3. Promoting competition through a managed model:

In theory, local telephony service and wireless services in Mexico[78] have been opened to competition since 1990 after the privatization of Telmex. However, in practical terms the government allowed the privatized company to maintain a de facto monopoly by postponing the establishment of clear rules that would guarantee new entrants a fair environment to compete or by delaying decisions when conceding licenses or auctioning frequency spectrum.

It was only in 1995 that a new Telecommunications Law was passed, just before Telmex's grace period in the long-distance market expired. The purpose of this law was to create a safe environment for the development of competition in all telecommunications markets. The main feature of the Telecommunication Law of 1995 was the introduction of a clause that allowed regulatory authorities to establish special obligations on service providers that were considered economic agents with substantial market power and the creation of a specialized regulatory body. However, significant gaps in the Law, lack of will to enforce measures to foster competition by the regulatory authorities, limited independence of the regulatory agency and weaknesses in the performance of judiciary prevented the 1995 Telecommunications Law from achieving the purpose for which it was created.

The *Comision Federal de Telecomunicaciones* (COFETEL), the new regulatory body, was created as an entity independent of the *Secretaria de Comunicaciones y Telecomunicaciones* (SCT). However, despite the creation of an independent agency, the SCT retained substantial regulatory power. While the COFETEL was in charge of providing advice to the SCT, the latter retained the power to provide Concession Titles and permits for new entrants, to enforce regulation through the determination and implementation of fines on telecommunications operators or other actors who violated regulatory rules and to define policies aimed at achieving social development goals. In this context, not only was the regulatory agency dependent on the Secretariat; its powers were mostly limited to an advisory role rather than a decision-making one.

3.1. Restricting entry in the local exchange sector:

In addition to having a subordinated role, the COFETEL was highly influenced by a philosophy that favored the incumbent over new entrants, as can be observed in a number of instances:

- As mentioned above, the market for provision of local services was, in theory, open to competition since 1990. In fact, by 1994 several applications to enter local telephony had already been submitted to the COFETEL. In particular, Iusacell, a mobile carrier, proposed providing the service by means of fixed wireless technology. However, it was not until October 1997 that the rules for the development of competition in local

[78] In 1990, Wireless services were liberalized because they were considered value added services and not telephony service.

telephony were published. In practical terms, competition for local service started in 1999 after Cofetel auctioned a substantial amount of spectrum suitable for the provision of PCS and wireless local loop applications[79].

- Nextel, which operates as a trunking service provider, was not considered a local service provider. This implied that the company had to lease numbering schemes from other companies. In 2002, the company decided to ask for a license to provide local telephony service, but three years later the COFETEL had not provided an answer to the request. In 2005, Nextel presented a complaint to the *Secretaria de la Funcion Publica* against the Cofetel for inefficiency in fulfilling its responsibilities.
- In 2005, GTM (owned by Movistar) asked for a concession to provide local service using wireless technology. The Spanish company had to wait for more than two years for the concession to be granted.

3.2. Using interconnection charges as barriers to entry:

The establishment of interconnection agreements is the center of gravity of a competition policy, insofar that it prevents network effects of an incumbent from acting as a barrier to entry of new operators. The Mexican regulator has used this tool to benefit Telmex to the detriment of new entrants.

3.2.1. Fixed and mobile networks interconnection:

After an unsuccessful round of lengthy negotiations between Telmex and the mobile operators with respect to interconnection terms, the SCT established charges for interconnection between fixed and mobile operators in July 1990:

- A charge of US$ 0.055 per minute was set for terminating mobile calls on the fixed network. The mobile operator would charge its mobile subscriber the airtime rate per minute, and out of that it would pay the fixed operator US$ 0.055 for each minute terminated on the fixed network;
- For calls from the fixed network to a mobile network, a charge of US$ 0.036 per minute was set. Initially, it was the mobile operator who was to pay this charge in order to alleviate the burden to the fixed subscriber when he/she made a fixed-to-mobile call. However, in October 1991, responsibility for paying it was transferred to the fixed subscriber making the call (under "calling party pays" regime). The mobile operators did not receive any interconnection charge for terminating calls originating on the fixed network. The fixed subscriber had to pay the local service tariff (which is a rate per call, not per minute), plus the origination charge of US$ 0.036 per minute. As a result, Telmex ended up collecting from the fixed subscriber the local service tariff per call plus the origination charge per minute.

[79] After the privatization of Telmex and its wireless arm, Telcel, despite the fact that the wireless market was open to competition since 1990, there was no spectrum auction until 1995,. After the 1995 auction, it had to pass almost 10 years to have a new spectrum auction

These examples indicate how Telmex appeared to be systematically benefited in the negotiation of fixed/mobile interconnection.

3.2.2. Long Distance interconnection:

After the expiration of Telmex's grace period in long distance, a dispute emerged between competing carriers and Telmex regarding the interconnection fee to be charged. On April 26, 1996, the SCT set the interconnection rate at 2.5 U.S. cents, with an additional surcharge of 2.8 U.S. cents, for a total of 5.3 U.S. cents for 1997 and 1998. The surcharge was justified as a necessary subsidy of Telmex's local residential operations to avoid a sharp rise in residential tariffs due to lost income on the long-distance market, while the company completed a delayed rebalancing of local and long-distance service tariffs[80].

On November 27, 1998 the COFETEL settled a new disagreement over interconnection charges applicable for 1999 to 2000 and reduced the interconnection tariff to 2.6 U.S. cents by dropping the 2.5 U.S. cents surcharge and adjusting the prior rate to inflation to the national consumer price index. Despite the decrease, in March 2000, the interconnection rate in Mexico was still 200 times as high as tariffs charged in the U.K., U.S., Argentina, and Canada.

3.3. Profiting from a weak judiciary environment:

In addition to its ability to negotiate favorable terms on regulatory matters, Telmex was benefiting from a legal framework that promoted the filing of delaying tactics throughout its proceedings. While the 1995 Telecommunications Law gave the power to regulatory authorities to impose special obligations on operators that are found to have significant market power, operators can rely on a judicial tool called "amparo", which is a recourse for the protection of an individual's constitutional rights to delay the resolution of matters that could be adverse to their position. By relying on this recourse, and exercising pressure on the judiciary, Telmex has been able to frequently block the enactment of pro-competition policies. For example:

- In 1997, the Mexican Competition Authority (Cofeco) found Telmex to have significant power in five relevant telecommunications markets (basic local telephone service, access, national long distance, interurban transport, and international long distance. Telmex presented an "amparo" and the court ruled in Telmex' favor;

- In 2007, the Cofeco opened an investigation regarding market dominance and concluded in 2009 that Telmex had significant market power in the local telephony service. As of this writing,

[80] Cofetel considered this as a necessary measure that "includes a contribution to cover what (the authority believes is a deficit in the provision of residential telephone service (…and) to prevent an additional sharp increase in residential service rates".

Telmex has threatened the regulatory authority with using another “amparo” if there is not an arrangement in the conditions that would be imposed as a result of this finding;

- In 2008, the SCT established an interconnection price of 0.54 pesos based upon a cost model, but that rate could not be applied due to the recourse raised by Telmex. Because of this, the government has tried to negotiate with Telmex to get the company to accept this rate in exchange for a modification of its license in order to allow the company to provide pay-tv services;

- The consolidation of local dialing codes was expected to begin in November 2008, but Telmex appealed to the judicial courts which ruled in favor of the incumbent to suspend the measure.

3.4. Limiting cable TV operators' entry into local voice telephony:

Cable TV operators started providing broadband services in 2003 under a permit allowing cable and wireless service providers to offer bidirectional data transmission services. This resolution was at the origin of the need to modify the Telecommunications Law.

Soon after obtaining permission to operate in the internet market, the cable TV industry started lobbying the regulator to allow cable companies to offer telephony services. However, Telmex was successful in delaying this modification through 2006. In fact, the SCT did not modify the license of pay-tv providers, although it had agreed to do so in 2004, until the Convergence Reform was approved by Congress in 2006.

3.5. Restrictions to foreign investment in wireline operations:

Telmex market dominance has been enhanced by FDI restrictions, which limit the possibility of building a pro-competition model. As mentioned above, the Mexican law determines a 49% foreign ownership limit for any fixed line telecommunications operator. As a result, foreign participation in the Mexican telecommunications wireline market is limited to institutional investors. This rule does not apply to the wireless industry (see figure 1).

Figure 1. Mexico: Capital Structure of Telecommunications Players

Carrier	Primary Investor	Institutional investor	Private investor	
			Family	Percent ownership
Telmex (fixed)	Carso (71%)	18 investors (29%)		
Maxcom (fixed)	Bank of America (40%)	13 investors (13%)	•Vazquez •Aguirre	46.89%
Axtel (fixed)		23 investors (20%)	•Milmo •Santes	80%
Alestra (fixed)	Grupo Alfa (51%)	ATT (49%)		
America Movil (mobile)	ATT (23.4%)	70 investors (26.5%)	•Slim	50.1 %
Iusacell (mobile)	Movil Access (55.5%)	5 investors (29.1%)	•Salinas	15.45%
Movistar (mobile)	Telefonica (100%)			
Nextel (mobile)		110 investors (98.7%)		
Megacable (cable TV)		28 investors (49%)	•Yamuni	51%
Cablemas (cable TV)			•Alvarez	100%
Cablevision (cable TV)	Televisa (100%)			

Foreign Investors

Source: Company reports

The 49 % foreign ownership limit for fixed=telephony operators is at the core of the lack of infrastructure-based competition. Due this rule, there appears to be difficulty in mounting a viable competitive challenge to Telmex.

A bill is now being considered by the full Congress to remove this restriction. In the past year, the economic committee of Mexico's lower house has approved proposals that would loosen or remove the 49 % foreign ownership limit. The ruling seeks to "reform legislation on foreign investment, to establish adequate conditions for promoting investment in the telephony sector and related services, with the aim of having users benefit from the increased competition."

The economic committee's secretary and member of the PRD party criticized the ruling saying that it would favor companies like Spain's Telefónica without obliging such companies to invest in rural or underserved areas not seen as profitable. Telmex has used this argument in the past to defend the foreign investment cap law. Furthermore, it was added that the reform proposal also failed to add a reciprocity clause entitling Mexican companies to invest in the basic telephony business in those countries of origin of the potential new foreign investors in Mexico. The bill will now be considered by the full Congress, although it has not been confirmed whether the legislation will consider investment of 100% by foreign companies; no date has been announced for a final decision.

4. A highly concentrated market structure:

As one would expect, a systematic bias toward raising barriers to entry has enabled the incumbent to retain a large share of the total telecommunications market (see figure 2).

Figure 2. Mexico: Telecommunications Sector Market Structure (2009)

	Local fixed	Long Distance	Broadband	Wireless
Telmex/AMX (*)	86.2 %	67.0 %	76.3 %	65.9 %
Axtel/Avantel	8.1 %	14.0 %	1.6 %	--
Alestra	3.3 %	9.0 %	--	--
Telefonica	--	--	--	14.1 %
Iusacell	--	--	--	5.8 %
Nextel	--	--	--	14.2 %
Maxcom	1.6 %	--	1.0 %	--
Megacable	0.8 %	--	5.8 %	--
Other	--	10.0 %	15.3 %	--

Note: Shares are calculated of revenues and not subscribers

(*) Telmex and AMX (America Movil), historically owned in part by Grupo Carso, are in the process of merging.

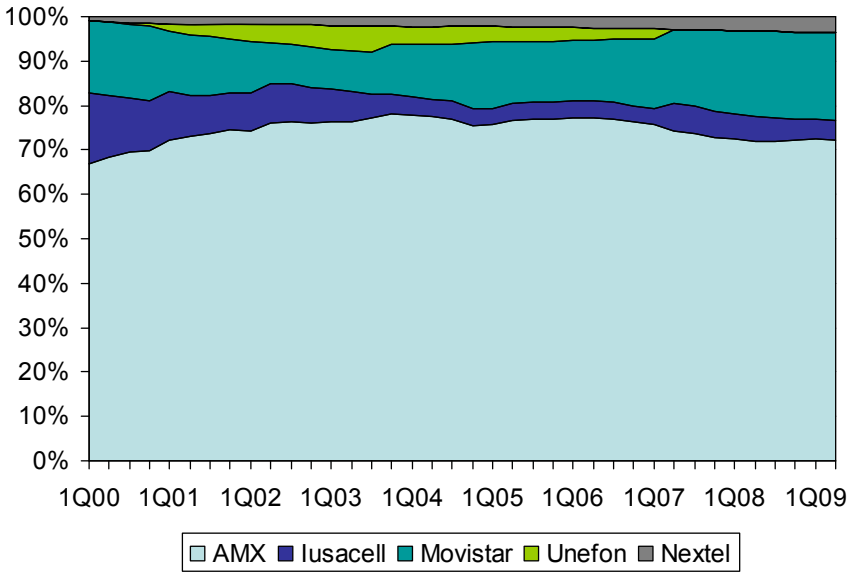
Sources: Pyramid Research; Merrill Lynch; analysis by the author

As figure 2 indicates, Telmex controls 86.2 % of the local fixed line, 67% of long distance and 76.3 % of the broadband market, while America Movil (50.1 % owned by the Slim family) has 65.9 % of the wireless market. As a result, from a revenue standpoint, Telmex controls 79.8 % of the total Mexican telecommunications market.

Beyond Telmex, the fixed-line local market is shared between Axtel (8.1 % share through a WLL offer) majority owned by the Milmo family, Maxcom (1.6 %), and cable operators. The wireless market is served by AMX (65.9 % share), Movistar, owned by Telefónica (14.1 %), Iusacell (5.8 %) and Nextel (14.2 %), owned by the NII consortium. The broadband market is split between Telmex (76.3 %), and cable TV operators (8.2 %). Within this group of cable companies, the most important are Megacable (5.8 %), owned by Cablemas, and Cablevision (2.4 %) owned by the Televisa Group.

Beyond the large share of the market controlled by Telmex/AMX, changes in market share over time have marginally occurred at the expense of the incumbent but more as a result of mergers, acquisitions and exits among the challengers (see figure 3).

Figure 3. Mexico: Evolution of subscriber market share in wireless



Source: Merrill Lynch

As the figure 3 indicates, the Mexican wireless market has been gradually concentrating into a triopoly, in which Telmex controls over 70% of the subscriber base.

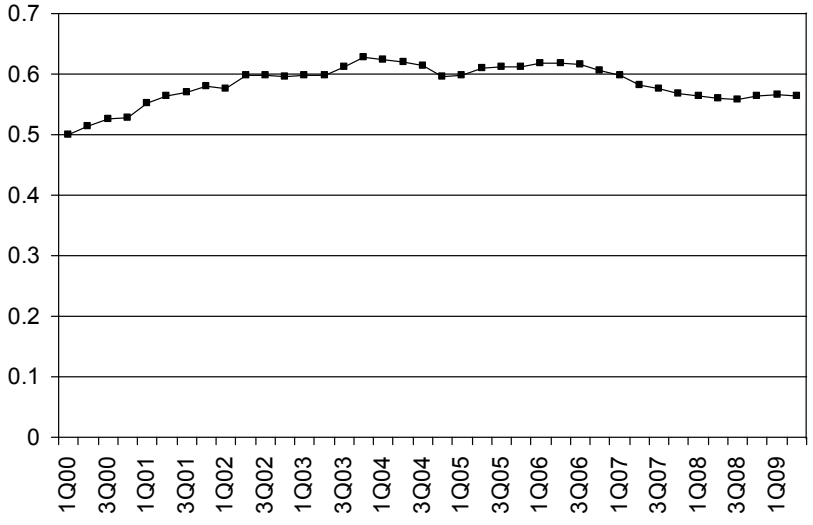
In comparative terms, not only does Mexico exhibit the second highest HH index in telecommunications in the Americas (see figure 4), but the metric has remained fairly stable throughout the past nine years (see figure 5).

Figure 4. Latin America: Wireless Hirschman-Herfindahl Index (2008)

Position	Country	HHI
1	Ecuador	0.59488
2	Mexico	0.565
3	Panama	0.52608
4	Colombia	0.52
5	Honduras	0.49217
6	Peru	0.483
7	Chile	0.36525
8	Uruguay	0.3602
9	Guatemala	0.34274
10	Paraguay	0.34153
11	Bolivia	0.3389
12	Argentina	0.32082
13	Brazil	0.25275

Source: Merrill Lynch; analysis by the author

Figure 5: Mexico: Evolution of Wireless HH Index (1Q00-2Q09)



Source: Merrill Lynch; analysis by the author

Due to this level of concentration, and the existing foreign investment restrictions, a number of original market entrants have left Mexico over the past ten years (see figure 6).

Figure 6. Foreign Investors in the service provider segment that have departed from the Mexican market

Investor	Divestiture	Date	Reason
Motorola	Sale of wireless operations in northern states	Jun 2001	Exit of the wireless service business
Verizon	Sale of Iusacell share	July 2003	Shrinking customer base and declining revenues after investing around US$1bn
MCI	Sale of 49 % share of Avantel to Axtel	4Q2006	With Verizon's acquisition of MCI, divestiture of non-core overseas subsidiaries
Korea telecom	Sale of its 49% share of Miditel to Mexican co-owner	1999	
Bell Canada Intl	Sale of its 9 % share of Axtel to Nortel	2003	
Global Light	Sale of its 49 % share (jointly with Mexican co-owner's 51%) to Televisa	2007	

5. Resulting sector performance:

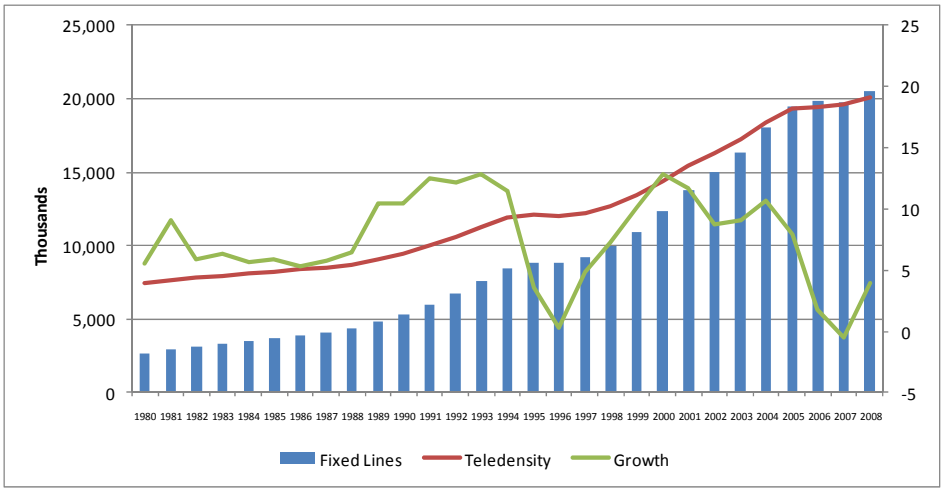
The analysis of sector performance following the privatization of Telmex and the attempts to open the market to competition covers service penetration, product innovation, pricing and service quality.

5.1 Service Penetration

5.1.1. Wireline service adoption:

The evolution of telecommunications service diffusion in Mexico is driven not only by the sector policies implemented but also the country's macro-economic conditions. The relative importance of both variables can be seen when examining the evolution of teledensity[81] since 1980 (see figure 7).

Figure 7: Mexico: Evolution of Fixed Lines (1980-2008)



Sources: ITU; analysis by the author

Figure 7 depicts four clearly-defined periods of wireline growth. From 1980 to 1988, access lines were growing at approximately 6 % per annum reflecting government planning assumptions. The second period (1988-1994), comprises the two years just before the privatization when the government invested in the deployment of the network as a strategy to increment the value of the company, and the four years after the privatization when the stock of fixed lines grew, following the conditions of the concession, at a rate of 12% annually.

In December 1994, the value of the Mexican currency collapsed from 4.0 pesos to the dollar to 7.2 in a week, leading to a recession that lasted more than a year. The recession resulted in a negative growth rate of wired telephony[82]. In 1996, the teledensity growth rate recovered opening the second period of wireline development (1996–2001). At this point, growth was also partially stimulated by the introduction of fixed line competition in 1999. As such, in 2000, with the economic crisis over and the opening of local exchange competition, the growth rate

[81] Teledensity is defined as fixed lines as percent of total population.

[82] This effect was also observed during the Great Depression in the United States. Under monopolistic market conditions, negative growth rates in service adoption are driven by economic contractions rather than conventional business cycles.

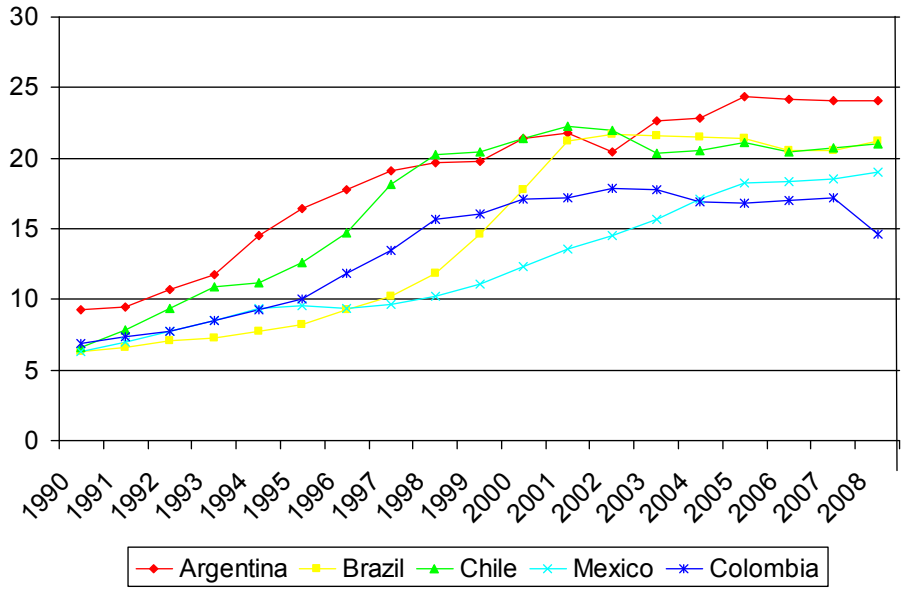
reached levels similar to those achieved before 1994. However, after the dot.com crisis the market experienced another downturn.

The third period extends from 2002 to 2008, with a recovery in industry growth. However, growth rates never returned to those of 1994 since wireless substitution started to affect wireline growth. On the positive side, however, there are signs of a slight recovery in teledensity growth driven by the introduction of competition from cable TV operators after they were authorized to offer telephony services.

The examination of wireline growth indicates that: 1) the strongest impetus for diffusion came from the privatization of Telmex, and 2) the impact of competition has been fairly limited as a result of a limited opening in the mid-1990s and a late entry of cable operators. The liberalization path followed by Mexico indicates a lag in the introduction of competition. This strategy differs from that of other Latin American countries such as Argentina, Brazil, Colombia and Chile, which exhibited better results than the ones obtained by Mexico in terms of wireline service adoption (See figure 8).

Figure 8: Latin America: Penetration of Fixed Lines (1990-2008)

(percent of population)



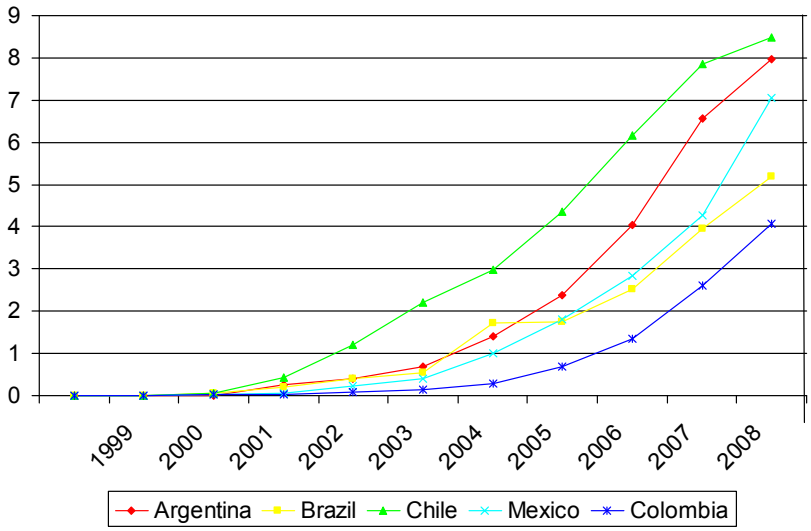
Source: ITU; analysis by the author

The comparison of the Mexican and Brazilian experience is particularly relevant. The period following the incumbent privatization in both countries exhibits a dramatic difference in terms of the growth in penetration. While in Brazil a regulatory framework and a pro-competition policy were defined before the privatization, in Mexico these measures were postponed until the period of exclusivity was about to end, allowing the incumbent to manipulate the outcome according to its own interest.

5.1.2. Broadband service adoption:

Broadband penetration, comprising both ADSL and cable modem services, in Mexico has displayed disappointing results until the introduction of competition from the cable TV industry in 2003 (see figure 9).

Figure 9: Latin America: Broadband penetration (1997-2008)



Source: ITU; analysis by the author

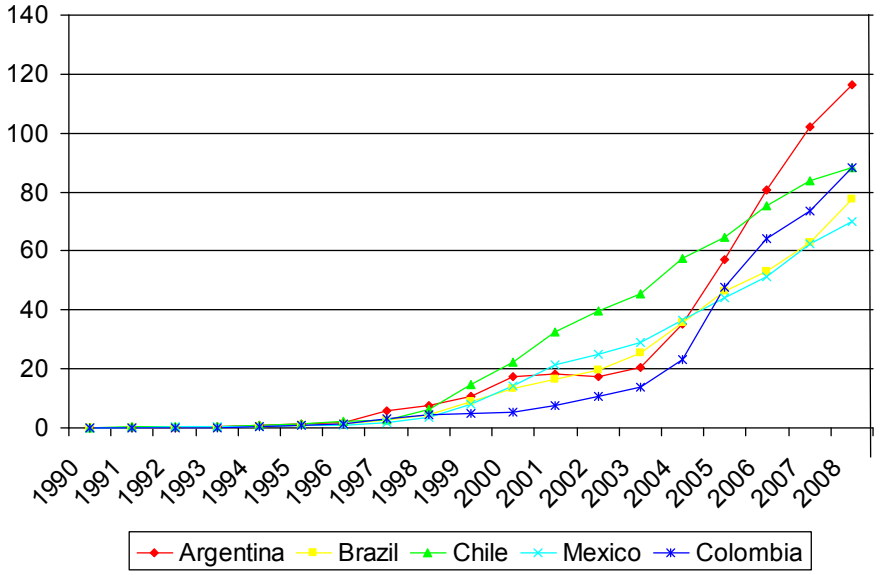
Broadband penetration in Mexico was lagging Argentina and Chile and, until 2004, Brazil. In 2003, when the cable TV operators were authorized to offer broadband services, Telmex responded by launching an aggressive service offer, coupled with subsidized PCs. Based on this effort, Mexico has rapidly reached the level of Latin American country leaders. However, broadband policies still benefit mostly cable TV operators since the fixed-line telecommunications incumbent (Telmex) is prohibited from providing triple play services, therefore reducing the value of its broadband offer.

At this time, the government has defined a target to significantly increase broadband penetration by 2012 by stimulating more competition. For this purpose, a national fiber optic infrastructure will be auctioned in order to be able to deploy a backbone network which would be an alternative to Telmex', with the objective of eliminating specific market bottlenecks. Nevertheless, the government has so far failed to develop and implement a universal broadband policy.

5.1.3. Wireless service penetration:

The clearest effect of the managed competition model adopted by Mexico can be seen in the wireless market. The Mexican strategy has relegated the country to last place in terms of penetration rates among similar Latin American countries (see figure 10).

Figure 10: Latin America: Wireless penetration (1990-2008)



Source: ITU; analysis by the author

In Argentina, Brazil and Chile, the regulators have fostered the entry of new players in the mobile market. As a result, Argentina has three wireless players with significant market shares, while the other two countries have four. On the other hand, the strategy followed by Mexico's policy makers was to allow the growth of the incumbent expecting that in a scenario with limited competition, the incumbent would deploy its network faster. Comparing the two strategies, it seems that in countries that fostered competition high penetration levels were achieved faster.

5.2. Universal service adoption:

The goal of providing service to the segments in the bottom of the pyramid has been successfully achieved in the Mexican fixed-telephony market, where penetration at the lowest income deciles is the second highest in Latin America. (see figure 11).

Figure 11. Mexico: Household Ownership of a Telephone Line by Income Level % (2007)

Decile	Argentina	Brazil	Chile	Colombia	Mexico
1	42.2	12.6	22.2	21.2	35.1
2	51.5	22.5	30.9	30.9	46.8
3	60.5	30.4	39.4	39.7	56.5
4	67.4	37.9	46.7	47.5	64.1
5	73.7	46.8	53.6	56.8	71.7
6	79.3	54.2	58.9	64.4	77.5
7	82.7	60.0	62.9	70.3	81.7
8	86.0	65.0	66.3	75.1	85.2
9	88.6	69.0	68.9	79.1	87.9
10	90.6	73.7	70.3	82.0	90.5
Total	72.2	47.2	62.5	53.7	69.7

Source: Euro Monitor International

On the other hand, the mobile and broadband markets show disappointing results in comparison to the most important markets in Latin America (see figures 12 and 13).

Table 12. Latin America: Household Ownership of a Mobile by Income - % (2007)

Decile	Argentina	Brazil	Chile	Colombia	Mexico
1	53.0	41.8	49.4	37.1	42.7
2	70.5	56.0	59.3	53.0	53.3
3	82.0	67.0	67.8	64.4	62.6
4	86.7	74.5	75.0	72.8	70.5
5	91.0	80.1	80.6	79.3	76.4
6	94.0	84.6	84.6	84.0	81.1
7	96.0	88.1	88.3	87.2	85.0
8	97.0	91.5	91.3	90.3	88.3
9	98.0	94.5	94.2	93.3	90.9
10	98.5	97.0	97.7	95.5	94.5
Total	86.7	77.5	79.5	75.7	74.5

Source: Euro Monitor International

Figure 13. Latin America: Household Ownership of a Computer enabled with broadband by Income - % (2007)

Decile	Argentina	Brazil	Chile	Colombia	Mexico
1	0.8	0.7	4.2	2.4	0.3
2	1.8	1.6	7.4	3.1	0.6
3	3.0	2.5	10.8	3.8	1.0
4	5.8	4.7	15.1	5.2	1.8
5	7.8	6.3	19.2	7.3	2.5
6	11.5	8.6	23.9	10.0	3.4
7	13.7	10.6	28.6	15.0	4.9
8	19.9	15.2	36.1	21.9	8.0
9	30.4	23.2	42.9	32.2	14.3
10	40.1	29.9	51.8	48.2	24.2
Total	13.5	10.3	24.0	8.6	6.1

Source: Euro Monitor International

5.3 Innovation:

The dynamic efficiencies of the Mexico managed-competition model can be analyzed based on the evolution of broadband download speeds as well as the adoption of 3G wireless networks.

Mexico is still lagging other Latin American countries in terms of broadband speeds. Moreover, the offerings of incumbents in other countries in the region are at least twice the speed of Telmex in Mexico[83] (see figure 14).

[83] It should be mentioned that Megacable is the only operator that currently offers speeds above 4 Mb in Mexico, but it still does not provide competitive pressures because the service is not widely available.

Figure 14: Latin America: Comparison of broadband prices among incumbents and cable TV operators (USD)

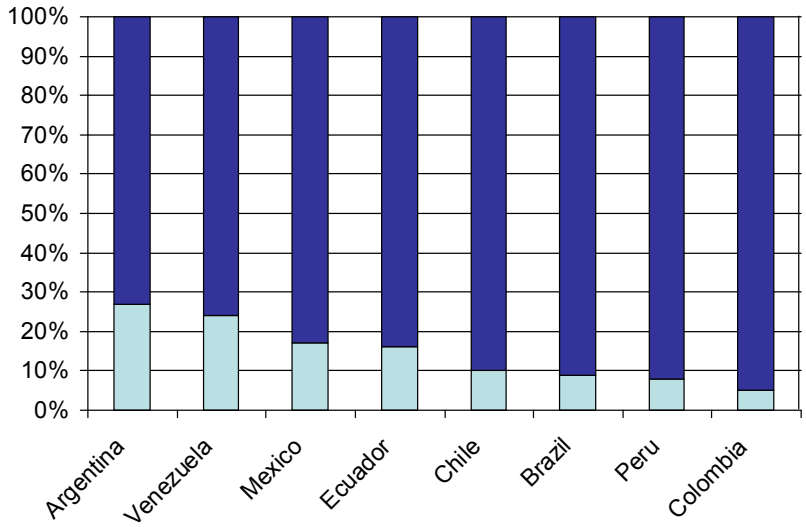
Country	Company	Minimum Speed		Medium Speed		Maximum Speed	
		Download Speed	Price USD	Download Speed	Price USD	Download Speed	Price USD
Mexico	Telmex	1Mb	22.40	2 Mb	44.87	4 Mb	89.74
	Megacable	1Mb	14.91	2Mb	22.40	10 Mb	59.85
Chile	Telefonica	1 Mb	29.91	4 Mb	39.55	8 Mb	53.00
	VTR	2Mb	41.15	4 Mb	45.90	15 Mb	56.97
Brazil	Telefonica	1 Mb	25.66	4Mb	42.02	8 Mb	93.43
	Net Servicios	3 Mb	49.03	6 Mb	65.39	12 Mb	112.12
Argentina	Arnet	1 Mb	19.46	5 Mb	36.58	20 Mb	118.82
	Fibertel	1 Mb	19.26	5 Mb	64.93	10 Mb	108.22

Source: Companies websites

With regards to wireless broadband, Mexico occupies the third position in Latin America in terms of adoption of wireless data services (as measured by percent of Average Revenue per User generated by these services)[84] (see figure 15).

[84] This situation could change for the introduction of Movistar 3G network in 2008.

Figure 15: Mexico: Data contribution to ARPU (Average Revenue per User) during 3Q08



Source: 3G Americas (2008)

This position is partly driven by delays in the adoption of wireless broadband technology. While Mexico represents more than 17 % of the mobile market in Latin America, the users of third-generation wireless broadband (HSDPA service) in Mexico only amount to 7 % (at levels similar to those of Argentina and Chile). On the other hand, Brazil marks a substantial difference with Mexico, representing more than 37 % of the HSDPA users in Latin America (see figures 13 and 14).

Figure 13: Latin America: Wireless Subs

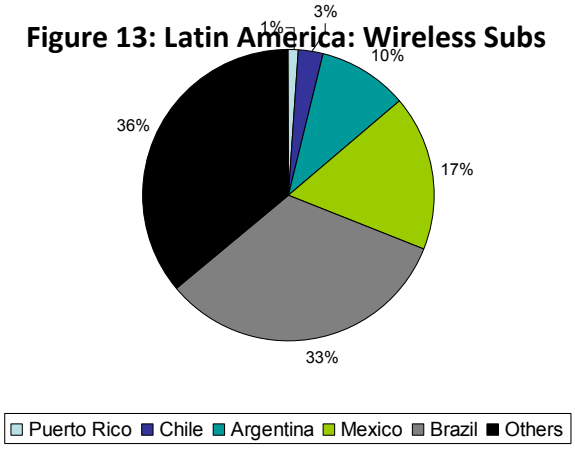
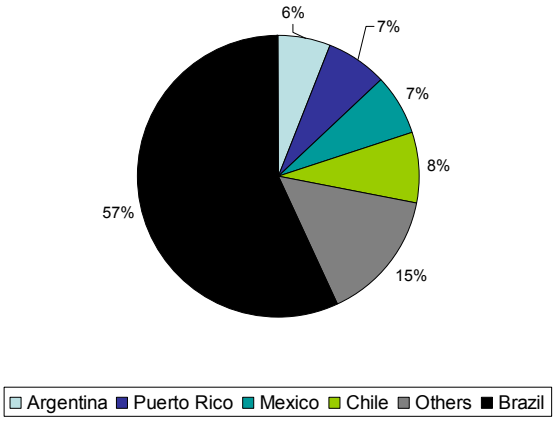


Figure 14: Latin America: HSDPA Subs

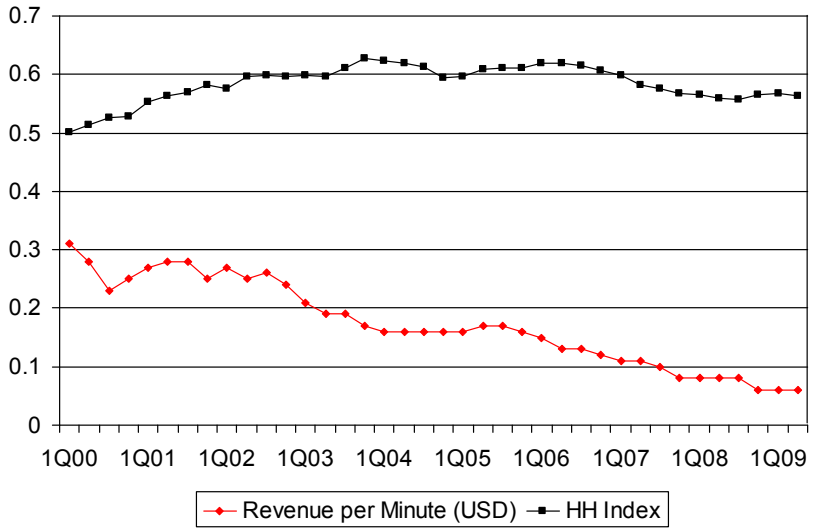


Source: 3G Americas, 2008

5.4. Pricing:

The pricing trends indicate that consumers have been receiving benefits despite the level of market concentration. Pricing of mobile services has been consistently declining since the year 2000 (see figure 15).

Figure 15. Mexico: Pricing of wireless MOU versus HH Index

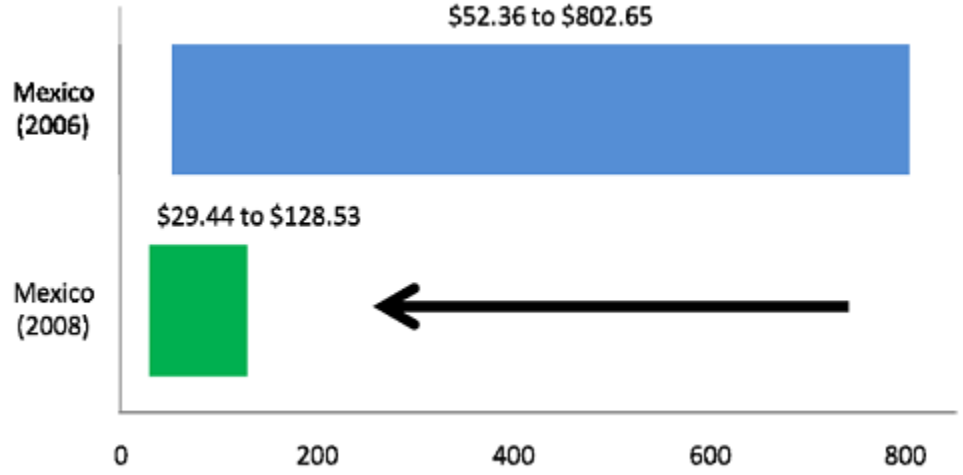


Source: Merrill Lynch

This would indicate that despite AMX's dominant position, the competitive activity of other carriers has been enough pressure to drive prices of the incumbent down.

Furthermore, the price of broadband services is a perfect example of the positive impact of competition. Pricing of broadband remained relatively high in Mexico until cable TV operators were allowed to enter the market. Only after the cable companies were allowed to provide "triple play"have the prices from broadband services fallen drastically. (See figure 16).

Figure 16. Mexico: Span of observed monthly subscription prices for broadband (USD PPP)



Source: OECD Communication Developments: Mexico (2009)

The resulting pricing in broadband indicates an alignment of prices (see figure 17)

Figure 17. Mexico: Comparable Broadband Services and Prices

Company	Minimum Speed		Medium Speed		Maximum Speed	
	Download Speed	Price USD	Download Speed	Price USD	Download Speed	Price USD
Telmex	1Mb	22.4	2 Mb	44.87	4 Mb	89.74
Megacable	1Mb	14.91	2Mb	22.4	10 Mb	59.85
Cablevision	450 Kbps	23.09	1.5 Mb	31.01		
Axtel	1Mb	29.29				
Cablecast	1.5 Mb	25.39	2 Mb	33.41	3 Mb	50.19

Source: Signals Telecom Consulting (2009)

As a result of competition, the current prices of broadband in Mexico could be considered relatively low compared to other Latin American countries (see figure 18).

Figure 18. Latin America: Comparative broadband prices (USD PPP)

Operator	Market	Downwlink	Price US$
NET	Brazil	500 Kb	41.02
		3 Mb	61.56
		6 Mb	82.09
		12 Mb	140.77
TELMEX	Colombia	2 Mb	35.71
		4 Mb	73.37
TELMEX	Chile	1 Mb	29.48
		2 Mb	48.14
		3 Mb	52.07
		4 Mb	56.00
TELMEX	Mexico	1 Mb	22.40
		2 Mb	44.87
		4 Mb	89.74
TELMEX	Peru	600 Kbps	31.63
		1 Mb	34.79
		2 Mb	48.85
		3 Mb	55.88
		4 Mb	73.46

Source: Signals Telecom Consulting (2009)

While the reduction of prices in broadband services has been the result of competition in the market, it is important to mention that this competition could be affected if Telmex is allowed to enter the pay-tv market using its IPTV ready network.

6. Conclusions:

The study of the Mexican telecommunications sector has shown that a very gradual market liberalization and hesitancy in opening markets has significant negative effects in sector performance. The privatization of Telmex had benefits in terms of accelerating the deployment of fixed-line telephony, in particular reaching high penetration at lower levels of the socio-demographic pyramid.

However, the incumbent was capable of establishing a significant number of barriers to entry in local telephony through either sector-specific (interconnection rates, license restrictions) or non-sector specific (limits to foreign ownership) means. These were reinforced by a legal system that guaranteed the capability of delaying any government attempts to liberalize the market. These barriers had a negative effect on wireline service deployment. The proof of the important positive contribution of competition toward sector performance lays both in the broadband and wireless sectors. The activity of cable TV operators in the former and wireless competitors in the latter resulted in a more dynamic market, leading to higher static and dynamic efficiencies.

Recent regulatory moves taken by Mexican authorities confirm the will to move sector dynamics to become more competitive. The SCT launched an auction for three concession licenses to operate dark fiber belonging to the state electricity company. This auction is aimed at boosting competition against Telmex wireline business. In addition, the antitrust authority has concluded that Telmex has a dominant position in call termination on fixed lines, while AMX has a dominant position in the wireless market. It remains to see whether these moves will result in stimulating competition.

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Section IV: Policy and Development of ICT

Part C.7: Pursuing Broadband Universal Service Through Government Funding and Platform-Based Competition: Sweden

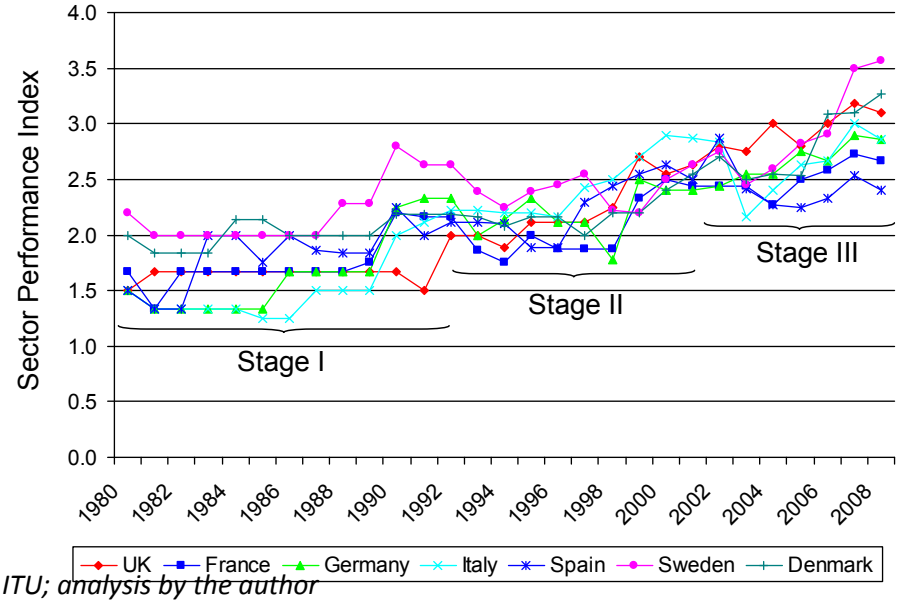
By Prof. Raul L. Katz

1. Introduction:

The Swedish ICT sector is one of the world's top performers in terms of telecommunications service adoption and quality, productivity, innovation and pricing. Sweden's top performance is based on having achieved the highest penetration of broadband among OECD countries (32 %), universal wireless adoption (114 %), and the third highest diffusion of fiber optics in the telecommunications local loop among OECD countries (20 % of broadband accesses).

A comparative analysis of the sector performance of Western European countries since the 1980s indicates that Sweden has been successful at retaining a top position over time (see figure 1):

Figure 1. Western Europe: Evolution of ICT Sector Performance[85]



Source: ITU; analysis by the author

The evolution of the Swedish ICT sector performance since 1980 exhibits three clearly-defined stages. Between 1980 and 1994, Sweden (jointly with Denmark) was a leading performer. Its superior position resulted from wireline adoption being approximately 60%, which was higher than its peers at the time. This situation changed in 1994 when the European countries' ICT sector began to perform fairly uniformly, as a result of Western Europe "catching up" in terms of wireline density and mobile services penetration. However, after 2003 Sweden (jointly with Denmark and the U.K.) reemerged as a group leader. Superior performance at this stage resulted from higher-than-average adoption of wireless broadband services and fixed broadband (more specifically, investment in fiber optics)[86].

The purpose of this case study is to assess the policies that allowed Sweden to achieve its superior position. At the highest level, four public policy initiatives explain Sweden's superior performance:

[85] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.
[86] In the case of the U.K., superior ICT sector performance was the result of higher than average wireless broadband services. In the case of Denmark, its leading position resulted also from high wireline broadband adoption, and fixed broadband deployment.

- Government financially supports the deployment of broadband in rural areas;
- Public investments in a backbone network and government support of ‘‘open’’ and ‘‘operator neutral’’ local and regional networks;
- Subsidies and tax allowances and other demand promotion tools to stimulate broadband adoption ;
- Active promotion of platform-based competition by cable operators and alternative carriers.

These four policies were implemented in the context of a vision and strategy formulated early on by the Swedish government. The following case study reviews the specific policies and planning efforts deployed by the Swedish government, the reaction of industry players to the said policies, and the results achieved.

2. Context:

The Swedish ICT sector is at present one of the most advanced in the industrialized world (see figure 2).

Figure 2. Indicators Swedish ICT sector performance (2008)

	Population Penetration			Household Penetration		
	Sweden	EU	OECD	Sweden	EU	OECD
Fixed Line Adoption	60 %	46%	43%	88 %	70 %	
Wireless Subscriber penetration	114 %	83%	99%			
Broadband penetration	32 %	23%	22%	89 %	49 %	60%
Personal Computers	88 %	46 %	54 %			

Sources: ITU (2009); Regeringskansliet, 2009

Fixed-line telecommunications have reached an adoption level of 60% per population, while wireless telephony exhibits 114 % penetration. Personal computers, which were introduced in 1982, reached an adoption of 82% per household by 2008. As expected, a large part of the causality of this performance is Sweden's high level of economic development. When compared with other developed countries of somewhat comparable GDP per capita, Sweden (jointly with Denmark) consistently ranks higher in terms of ICT sector performance (see figure 3).

Figure 3. Economic Development versus ICT sector performance (2008)

Country	GDP per capita	ICT Performance Index[87]
Denmark	62,579	3.44
Sweden	52,305	3.43
United States	46,194	3.13
Canada	45,278	2.57
United Kingdom	43,472	3.12
France	41,508	2.71
Germany	40,182	2.86

Sources: World Bank; analysis by the author

In addition, Sweden has benefited from a high level of urban concentration (85%), which favors diffusion of ICT.

On the other hand, the country has a comparatively lower level of population density, which presents some challenges in terms of achieving universal technology adoption in the isolated areas of the north. Along these lines, infrastructure investment in broadband in isolated geographies would be extremely low. It is in this context, that the Swedish government has enacted policies aimed at achieving universal adoption of broadband technology.

Sweden's current position in terms of broadband adoption according to most international benchmarks is relatively strong (see figure 4).

[87] The ICT Sector Performance Index has been calculated according to the methodology reviewed in the Statistical Analysis Module.

Figure 4. Sweden's Broadband Benchmark Rankings

Measurement	Sweden's Ranking	Source
Broadband Performance Index	4 (2008)	EC
Broadband Quality Score	4	Cisco and Said Business School (Oxford)
Network Readiness Index	2	WEF
Broadband Scorecard	3 (2008)	ECTA

Source: Sandgren (2009)

From a supply standpoint, 99 % of the population has access to broadband services (this metric includes mobile broadband). While mobile broadband provides access to between 94% (HSPA) and 99% of the population (CDMA 2000), fixed broadband providers offer service to between 98% (xDSL), 37% (cable modems) and 35% (fiber optics). Cable TV and fiber-based broadband access is deployed primarily in urban areas, which means that 30% of households and businesses are located within 250 meters of a building with such coverage (Regeringskansliet, 2009). In this context, only 4,400 households and small businesses do not have access to broadband service, while 117,000 households and small business only have wireless broadband access[88].

From a demand standpoint, Swedish Broadband penetration amounts to approximately 66% of households (see figure 5).

[88] However, it is worth mentioning that, according to the Swedish government, it is estimated that around 10% of households and businesses that are covered by wireless networks cannot receive "stable and functioning broadband".

Figure 5. Metrics of Sweden's Broadband Adoption

	Subscribers	Population (*)		Households (**)		Date
		Percentage	Ranking	Percentage	Ranking	
OECD	2,905,000	32 %	7	65.3 %		4Q08
Point Topic	2,937,602	32 %	10	66 %		4Q08
PTS	2.962.880 (e)	32%				4Q08
UBS	3,591,000	38.9 %		70 %	9	4Q08
ECTA	3,029,000	33.5%	3	68%		1Q09
Merrill Lynch	2,904,000	32.3%		65.3%		4Q08
ITU	3,421,000	37 %		77%		4Q08
ITIF	2,402,460			54%	6	2008

(*) 4Q08 population: 9,259,000

(**) households 4,449,000

Sources: As indicated in figure; Statistics Sweden

From a usage standpoint, 89% of the population had access to the Internet in 2009, while 83% did so with broadband. In addition, ninety percent of businesses accessed the Internet through broadband. In particular, 85% of small and medium enterprises used the Internet, while 74% of them had broadband access (Regeringskansliet, 2009).

The retail broadband market Swedish market is split between facilities-based telecommunications players, cable TV operators and "unbundlers" (companies that buy wholesale access from facilities-based operators) (see figure 6).

Figure 6. Broadband Service Providers (1Q2009)

Type of player	Players	Subscribers ('000)	Market Share (%)
Facilities-based telcos	TeliaSonera	1,122	36 %
	Telenor	350	11 %
	Tele 2	141	5 %
	Total	1,613	52 %
Cable TV	Com Hem	479	16 %
	Other	27	1 %
	Total	506	17 %
Unbundlers	Telenor	308	10 %
	Other	368	12 %
	Total	676	22 %
Other (Municipal, other providers)		265	9 %
TOTAL		3,060,000	

Sources: Companies' financial reports; Merrill Lynch; PTS; analysis by the author

As figure 6 indicates, facilities-based players, which comprise telecommunications companies, cable TV operators and municipal networks, control 78 % of broadband connections. As a peculiarity of the Swedish market, two strong telecommunications service providers compete for the broadband market over the national territory (see figure 7).

Figure 7. Telecommunications Service Providers in Sweden

	TeliaSonera	Telenor	Total
Revenues ('000'000 US$)	4,322.24	1,498.50	5,820.74
EBITDA ('000'000 US$)	1,399.84	295.95	1,695.79
CAPEX ('000'000 US$)	475.41 (e)	178.65	654.06

Source: Company Annual Reports

TeliaSonera has emerged from the merger of Telia, the partially government-owned incumbent and Sonera, from Finland (see figure 8).

Figure 8. TeliaSonera's Capital Structure

Shareholders	Percentage
Swedish Government	37.3 %
Foreign Holders	22.4 %
Swedish Institutional Investors	18.9 %
Finish Government	13.7 %
Swedish Private Investors	3.0 %
Finnish Institutional Investors	3.0 %
Finnish Private Investors	2.4 %

Source: TeliaSonera. Financial Report

The merger of TeliaSonera also triggered the emergence of two strong infrastructure competitors. Telenor, the Norway-based MNC, has aggressively pushed for inorganic growth in the Swedish market, becoming the second largest broadband player. In August 2004, Bredbandsbolaget, Sweden's second largest broadband provider, acquired its broadband rival Bostream. In May 2005, Telenor acquired Bredbandsbolaget and in 2006, Telenor acquired GlocalNet. The company had 250,000 fixed telephony customers and 180,000 broadband customers.

As a condition of the Telia/Sonera merger, Telia had to divest the cable TV operator Comhem. In June 2003 EQT took over Com Hem from the TeliaSonera group for 2.1 billion kronor. In December 2005, the Carlyle Group and Providence Equity Partners acquired Com Hem. And finally, in April 2006, the Carlyle Group and Providence Equity Partners acquired the Swedish TV and broadband services provider UPC Sverige AB from Liberty Global.

The consolidation of the broadband market led to the emergence of three dominant infrastructure-based players controlling 73 % of the market. This market structure represents a critical variable explaining the development of broadband in Sweden. However, it is important to underline that government policy also played a key role in driving market development.

3. Policy objectives:

Since early in the diffusion of the Internet, Sweden has been at the forefront in promoting broadband development. In 2000, the Swedish government enacted the "Information Society for All" bill, which established that broadband service should be considered a utility and every citizen should have access to it. This bill led to the development of the Broadband Support Program (2001-7) which focused funding to deploy broadband in rural and isolated areas and to build a national backbone to provide wholesale access points to all 290 Swedish municipalities, in direct competition with the incumbent telecommunications carrier.

In 2007, the telecommunications regulator, PTS, issued a broadband strategy with the objective of achieving universal service. The objective was to reach universal broadband penetration (defined as speeds in excess of 2Mbps) by 2010, while promoting sustainable competition.

Finally, in November 2009, the government released its Broadband Strategy for Sweden that formulated the following policy objectives:

- In 2015, 40 % of households and businesses should have access to at least 100 Mbs
- By 2020, 90% of households and businesses should have access to at least 100 Mbs
- All households and businesses should have the opportunity to access public services by broadband

To achieve these objectives, the 2009 strategy emphasized the encouragement of competition, and proposed a revised model for spectrum management to facilitate mobile broadband access in more remote areas, by exploring which frequency bands can be used for high-capacity access in currently underserved areas.

4. Description of policy approach and tools:

According to the 2000 Strategy, the support of the local and regional network was a priority of Sweden's broadband strategy. To pursue this objective the government defined three policies:

- Obliged state-owned companies to build a high-speed backbone infrastructure
- Provided financial incentives to municipalities to deploy high-speed infrastructure
- Provided tax incentives to boost broadband demand

4.1. State-owned backbone network:

The national backbone was conceived to become a competitive alternative to the incumbent telecommunications carrier so the incumbent backhaul network would not become a bottleneck in the development of local broadband networks. In 2000, the Swedish government commissioned the Swedish National Electricity Grid and the Swedish Rail Administration, Banverket, to deploy a fiber optic backbone to the main urban centers in Sweden aimed at connecting 290 municipalities. The goal of this proposal was to link all of the country's principal municipal centers in a countrywide network. By the year 2003, the network had connected 215 of the 290 municipalities.

4.2. Financial incentives to promote broadband deployment:

In addition to fostering the deployment of a state-owned backbone, a key feature of the Swedish broadband policy was to provide government funding to municipalities to stimulate local network deployment. For this purpose, the government provided funds of approximately 400 million Euros to foster broadband infrastructure development between 2000 and 2005. In 2007, the government decided to renew investing in infrastructure, assigning 864 million Euros, of which 50% were financed by EU structural funds.

The Swedish government emphasized the development of "open" or "operator neutral" regional and local networks within counties and municipalities. To support an optimal allocation of subsidies, local and regional authorities needed to fulfill a series of conditions:

- Obligation to draw a detailed infrastructure program
- Commitment to principles of competition policy
- Municipalities received funding if they connected to the national backbone

According to the funding mechanism, at least 5% of the costs needed to be contributed by the municipality and an independent operator needed to run the network.

Faithful to the pro-competitive principle, the government policy encouraged municipalities owning fiber networks in areas capable of supporting competition to either dispose of such operations or ensure that competition was not distorted. Consequently, any broadband network financed publicly should be open to service providers other than the network owner. Because of their capital intensity, fiber optic access networks are characterized by absence of competition and therefore should receive favorable treatment while adhering to principles of openness (allow third party providers access to their network).

4.3. Demand-based incentives:

In addition to network construction, tax incentives were given to businesses and residential taxpayers who signed up for broadband services[89]. According to this incentive, 50% of the costs of broadband deployment are deductible up to a maximum of 5000 SEK.

5. Pressure on the incumbent and the migration to platform-based competition:

5.1. Local Loop Unbundling and infrastructure sharing:

In parallel with the policies outlined above and in order to promote competitive entry, the regulator enacted rules for unbundling access of the incumbent's network. In March 2000, regulatory Local Loop Unbundling (LLU) obligations were imposed on Telia Sonera. While in 2003 the obligation of open access temporarily ceased, in 2004, Telia Sonera was declared to have significant market power, which led to the imposition of new LLU obligations. Fiber optic access was not included in the regulation. In July 2007, PTS decided to include TeliaSonera's fiber in the LLU directive from the European Union, but TeliaSonera appealed the PTS decision and on 29 February 2008 the county administrative court revoked the order issued by the regulator.

In parallel, TeliaSonera has successfully fought against any directives aimed at sharing ducts and providing access to dark fiber. There is no regulation in place regarding access to ducts, while duct sharing is not offered. The carrier has been obliged by PTS to provide dark fiber as backhaul to the MDFs. However, the decision was overruled by the administrative court. As a consequence, TeliaSonera does not have the obligation to provide dark fiber to wholesale customers. Furthermore, no aggregate information on ducts or dark fiber is available; it is only furnished on a case-by-case basis.

While the PTS contemplated regulating the dark fiber access market, it concluded in 2008, after a consultation, that the market was competitive enough without requiring regulatory intervention.

5.2. Functional Separation:

In addition to attempting to force the incumbent to provide wholesale access to it network and ducts, the regulator has been pushing to achieve functional separation of TeliaSonera. In June 2007, the regulator presented to the government a report containing a proposal to introduce a regulatory tool that would empower it to impose functional separation of the access network of an operator with significant market power. In June 2008, the Swedish Parliament adopted amendments to the Electronic Communications Act introducing functional separation as one of the remedies that could be imposed on an operator with significant market power:

- Functional separation can be introduced as a remedy imposed on SMP operators together with regulatory obligations of network access and non-discrimination
- Separation can be imposed on one or more markets by separate decisions or by the same decision, implying that market analyses are carried out for a cluster of local loop markets.

[89] This remains a key stimulus in a country where the marginal tax rate for the average taxpayer is 20%

The amendments entered into force in July 2008. In addition, in the same month, the regulator requested TeliaSonera to offer a wholesale bitstream access product to allow competitors to deliver IPTV and fiber LAN services

Furthermore, the regulator proposed to functionally separate TeliaSonera following the U.K. principles. As such, the regulator is encouraging the government, as a shareholder, to voluntarily agree to separate, as PTS considers that there is limited scope under the current Swedish Electronic Communications Act to impose separation as a sector-specific remedy. PTS proposes that the functionally (and/or) legally separated wholesale organization should provide the products which are currently regulated and which are, to some extent, attributable to TeliaSonera's fixed networks. PTS also envisages a complete separation of the workforce and suggests separating all wholesale human resources from the rest of the company as well as the elimination of any exchange of information between the wholesale organization and other parts of TeliaSonera that could benefit TeliaSonera's retail operations. A compliance board (including PTS officials) would continuously monitor the outcome of the proposed functional and/or legal separation model.

The forthcoming revision of the Electronic Communications Act could provide an opportunity for the regulatory authority to impose functional separation. However, the timing of the legislative process, which is reliant upon the revision of EU directives, would not allow new powers for PTS to enter into force before 2009 or 2010.

Reacting to the government pressure, TeliaSonera has agreed to functionally separate the local loop unit. In January, 2008, TeliaSonera established TeliaSonera Skanova Access AB which operates as a separate legal entity, offering the company’s passive infrastructure (ducts, copper, and fiber). The company is a LLC withits own board of directors independent from TeliaSonera’s retail business, overseen by an Independent Equality of Access Board to continuously monitor equal treatment of retail operators. Therefore, there is, in effect, legal separation of wholesale and retail sales of fixed network products.

6. Results:

Facilities-based competition has resulted in significant benefits in terms of market penetration, service quality and pricing. In addition, competition triggered accelerated investment in the deployment of fiber optics in the access network.

6.1. Broadband Adoption, Service Quality and Prices:

Competitive dynamics have resulted in very high speeds and one of the lowest prices in Europe (see figure 9).

Figure 9. Sweden: Broadband Speed and Pricing

Operator	Basic Speed			Intermediate Speed			Fastest Speed		
	Download	Upload	Price/ Month ($)	Download	Upload	Price/ Month ($)	Download	Upload	Price/ month ($)
TeliaSonera	1.5-2	0.2-0.25	32	12-24	6-8	46	50-100	N/A	N/A
Telenor	1.5-2	1.5-2	28	12-24	03-3	42	60-100	8-10	41
Com Hem	0.4-0.5	0.18-0.25	14	12-24	0.7-1	48	25-50	7-10	51
GlaveNet	1	1	28	30	30	46	100	10	49

Exchange rate: 7.14197 Kr per dollar

Sources: Companies' web pages; analysis by the author

Furthermore, infrastructure competition has pushed TeliaSonera to deploy high-capacity broadband. The acquisition of B2 by Telenor allowed it to roll out fiber-based broadband, particularly in the corporate segment. On the other hand, Telenor's purchase of Bostream and Glocalnet increased the carrier's market reach. With combination of fiber and ULL, Telenor started offering triple play based on VoIP and IPTV (currently 212,000 subscribers). In parallel, the cable TV company started offering triple-play services under the same brand and network. At the beginning of 2006, TeliaSonera's market share dropped to 40% which triggered a reaction along several dimensions:

- Deploy VDSL initially and begin offering FTTH in city centers
- Launch triple play offerings
- IPTV coverage area is 2.5 mm, with 320,000 subscribers by 2Q2008

6.2. Fiber Deployment:

Sweden is the country in Europe with the highest proportion of broadband access lines supported by fiber optics: fiber lines in Sweden represent 29 % of telco lines, and 20 % of all broadband accesses (see figure 10).

Figure 10. Sweden: Total Broadband Lines (000)

		6/05	12/05	6/06	12/06	6/07	12/07	6/08
Telco	ADSL	846	1,014	1,207	1,371	1,531	1,722	1,783
	FTTH	5	8	14	22	35	70	109
	FTTN	265	286	319	345	403	431	409
	Total FTTx	270	294	333	367	438	501	518
	Total Telco	1,116	1,308	1,540	1,738	1,969	2,223	2,301
Cable TV	Total	289	355	404	454	506	532	550
Fixed Wireless	Total	11	10	10	18	18	1	2
Other (*)	Total	9	9	8	6	7	1	1
Total		1,425	1,682	1,962	2,216	2,500	2,756	2,854

(*) LAN, Powerline, and satellite

Sources: PTS, Market data, ECTA; TAS analysis

The success of fiber deployment in Sweden is driven by three factors:

- Favorable household density: despite its extensive rural areas and low density (20 inhabitants per square km), the majority of its population is clustered in the south of the country (85% living in urban areas, while 3% live in small towns and 12% in rural areas), with 50% of Swedish households living in multi-dwelling units which are easily reached by fiber
- Strong infrastructure-based competition has pushed the incumbent to roll FTTN in urban areas to compete with Telenor and the cable TV operator
- Government investment programs aimed at subsidizing deployment within municipalities has accelerated adoption

Fiber penetration has initially been driven by non-incumbent operators and municipalities. Approximately 89% of the 500,000 fiber lines have been deployed by municipalities and Telenor[90]. The municipal networks cover 1.3 million households with fiber access[91]. Currently, there are 132 municipalities stating that they own and offer broadband access to end users via fiber-LAN or fiber directly in the home. They offer fiber access in 247of Sweden's 290 municipalities. In 86 municipalities

[90] For example, Bredbandsbolaget, a carrier acquired by Telenor has been deploying FTTB and offering VDSL2
[91] Reaching means that the household is within 100 meters from a fiber cable (25 m on average)

there was only one player offering fiber access and 19 of these were the municipality itself that owned the fiber access. As a result, 170 municipalities already have metropolitan area networks, of which 136 are fiber-based.

Municipalities that own their network usually have followed two business models:

- Municipality as a dark fiber provider: the municipality provides open access to its fiber. In this model the municipality does not act as a service provider or communication operator. (Stockholm, Vasteras)
- Municipalities as a service provider: the municipality acts as a service provider and communication operator. Usually, municipalities share access to their network. (for example, Gavle(*))

For example, Stokab is an example of a dark fiber provider. Founded in 1994, Stokab is owned by the City of Stockholm. Its mission is to give Stockholm an open ICT-infrastructure for all, create a network for the City of Stockholm, reduce digging in the streets of Stockholm, and stimulate the market by offering dark fiber below operator self cost. Stokab leases dark fiber, deploys “fiber to the neighborhood” and FTTB, relying on water, electricity and railway ducts as well as the metro infrastructure. It also cooperates with real estate companies for passive in-house cabling and the usage of micro ducts. Over 80 operators and service providers use the network and offer symmetric 100 Mbit/s connections. In 2006, Stokab’s tangible assets were estimated at EUR114 million. The same year, the company generated wholesale revenues of EUR 42.2 million. By 2012, Stokab’s network will cover 90% of all households in Stockholm

Finally, there appears to be some concern that municipalities are behaving in a non-competitive way. While funding was provided to municipalities to deploy infrastructure in areas where infrastructure competition was not feasible, they are starting to behave as commercial entities:

- Deploying infrastructure in areas where competition is feasible
- Refusing to provide dark fiber or access to their infrastructure
- Becoming full service providers
- Prices are not market driven

These are the issues that the PTS is trying to address.

Beyond municipalities and alternative carriers, the incumbent fiber deployment was triggered by competitive activity. Until recently, TeliaSonera had not tackled any major fiber roll-out, with the exception of scattered collaborative municipal projects. The carrier originally introduced ADSL2+ capable of delivering up to 24Mbps. Increasing demand for even higher speeds, especially for HDTV, and Telenor/municipalities moves drove TeliaSonera to begin deploying VDSL. The plan announced in March 2008 comprised the deployment of a mix of FTTB and FTTC/VDSL2, targeting 1.5-2 million households and businesses over 5 years:

- No plans to deploy remote DSLAMs in cabinets
- If fiber is deployed, it will rely on FTTB
- Plan will entail collaborating with municipalities, building owners and housing cooperatives

7. Conclusion:

Sweden's broadband success is based on the following policy tools:

- Formulation of a government plan, supported by a national broadband vision. The Swedish government enacted in 2000 a policy aimed at universalizing broadband service. This policy was put in place and updated in 2007 and 2009, when universality has been reaffirmed
- Government funding to support broadband deployment in isolated areas. In Sweden, government funding has been instrumental in promoting broadband adoption and fiber optic deployment. Broadband government promotion comprised financial incentives to municipalities for fiber deployment (E1.3 billion will have been invested between 2000 and 2010 to fund 2/3 of total investment).
- Broadband deployment incentives focused on the demand side. The Swedish government provides subsidies at the access level for development of neighborhood and household fiber:
- In Sweden, platform-based competition has been driving innovation and investments in broadband. Initially, an open access model on copper network (ULL) combined with cable competition with cable drove broadband penetration. This resulted in dynamic efficiencies resulting from more broadband application and services. Technology innovations led to continuous increase in broadband capacity. In this context, FTTH becomes the natural next step, whereby continuous investment remains critical for a platform-based competition scenario. The consolidation of cable operators and the gradual decline of unbundlers have not resulted in tacit collusion or winner-take-all situations

In conclusion, lessons can be learned from the Swedish experience regarding the creation the appropriate competitive conditions for broadband adoption and fiber optic penetration**.** Competition between three infrastructure-based network operators (cable TV and telcos) is sufficient to guarantee a strong push toward investment and innovation based on two alternative technologies. When the incumbent telco enters the FTTH/C arena, competitive dynamics push for a healthy rate of investment and product innovation on the part of the cable competitor. If the incumbent telco does not enter the FTTH arena, the industry fragments itself in a multiplicity of local providers (utilities, local telcos, and municipalities) with consequent diseconomies of scale. Having said that, there appears to be a market "zone" requiring government intervention to prevent failures: rural and disadvantaged areas. Governments address this, mixing indirect subsidies and municipal activity: there appears to be an opportunity for rationalizing government intervention in this area (coherent subsidy framework, definition of public/private partnerships).

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Section IV: Policy and Development of ICT
Part D: Appendix: Impact of Public and Regulatory Policy on ICT Sector Performance: A Review of the Research Literature

By Raul L. Katz (Columbia University) and Javier Avila (Columbia University)

1. Introduction:

The purpose of this paper is to review the research literature focused on understanding the impact of policy variables (regulatory framework, public policy initiatives, and institutional framework) on performance of the ICT sector. When referring to ICT, we focus primarily on the telecommunications sector, recognizing that ICT development as a category includes other areas such as adoption of computers, nature of computer applications and services, etc. We assume that, while excluded, some of these areas are co-related with the development of the telecommunications sector.

Understanding causality between policy and sector performance requires the creation of metrics capable of being subject to statistical analysis. In reviewing the literature, we have first focused on how researchers have attempted to measure policy frameworks. Following that, we review the literature aiming at building causality between policy and sector performance. Recognizing the wealth of research literature in this domain, we have selected the studies to be reviewed on the basis of their recognition as seminal pieces by virtue of their number of citations. This review is organized by platform, assessing causality with regards to broadband development and pricing, then wireless, and finally wireline. The last section focuses on policy impact on generic sector performance (capital investment, productivity).

The final section summarizes all the literature in terms of its contribution to the body of evidence and develops the implications for the construction of the theoretical framework and statistical model of our study.

2. Development of Regulatory and Policy Index:

Five indices measuring ICT regulatory and policy environments have been identified: the ECTA Scorecard; the Regulatory Density Index developed by Zenhausern et al. (2007); REGUL developed by Gutierrez (2003); the Policy Index, developed by Warren (2000), and the height of barriers to trade and investment in telecommunications developed by Lim et al. (2009).

The purpose of the ECTA scorecard is to compare the regulatory environment in 18 EU Member States, Norway and Turkey in the electronic communications sector and its effectiveness in promoting the objectives of the EU regulatory framework. This scorecard is divided into five sections: (a) overall institutional environment, (b) key enablers for market entry and network roll out, (c) the NRA's regulatory processes, (d) application of regulation by the NRA, and (e) regulatory and market outcomes (see detail in Appendix I).

Each question is answered using a maximum, intermediate and minimum scale. In order to aggregate the sections, a weighted addition procedure is used. The vast majority of questions have been weighted 'medium', equivalent to a maximum possible score for each question of 4.7, to signify that, in the absence of any evidence to the contrary, it is assumed that they have an equal contribution to the effectiveness of regulation. A 'high' (9.5 points) or 'low' (2.4

points) weight has been applied to balance the weightings in a particular section, such that there is neutrality in the weightings amongst the type of questions asked.

Weeks and Williamson (2006) have criticized this approach in terms of the underlying premise that more regulation is better regulation. For instance, in section E4 of the Index (which considers whether the provision of wholesale broadband access is competitive)[92], the fact that a country has ULL regulation and sets tariffs for this service will positively affect the sum of the indices in the ECTA scorecard. The problem with this assumption is that when trying to establish a relationship between investment and regulation, if we consider the ECTA scorecard as a whole and not as a group of subsections, we could conclude that more regulation would affect investment positively. It is important to mention, however, that the ECTA Scorecard does not attempt to establish such a relationship; it only tries to measure the degree of regulation of a country. It is the researchers' responsibility to know how to interpret the variables that they are using.

In contrast to the ECTA Scorecard, Zenhausern at al. (2007) developed a Regulatory Density Index whose purpose is to compare the intensity of regulatory environments in 27 European countries. The regulatory index is divided into four sections: (a) price regulation, (b) quantity regulation, (c) market-entry regulation, and (d) miscellaneous regulations relevant to investment incentives. Each section comprises several indicators (see Appendix II) which are assigned a value on a scale ranging from weak to strong intervention and, contrary to the ECTA Scorecard, are weighted differently. For example, liabilities to inform are a weak form of regulation while qualitative standards have a greater intervention density. Quantitative standards receive even greater weight and approval obligations are weighted heaviest.[93] In order to determine a weighting scheme for each indicator with enough robustness, four additional scenarios were calculated: a basic one in which all areas weight equally (25%) and four more in which the weight of one section is the double of the other three[94]. In order to test for robustness, the five scenarios were compared and the authors found the results (and therefore, the index) were not sensitive to the aggregation rule.

REGUL, developed by Gutierrez (2003), is an index measuring the regulatory framework in telecommunications for every country. This index has three dimensions. The first reflects whether there is separation between the telecommunications service provider and regulatory activities (quantified by the ITU), although not necessarily whether there is a specialized and separate regulatory body. The second dimension reflects four features of independent regulatory agencies: (i) whether the regulatory body has autonomy (e.g., whether there is budgetary independence or limits on government's ability to freely replace regulators, (ii) accountability, measured by existence of mechanism to resolve disputes between regulators and operators, (iii) clarity of the regulators' roles in terms of ability to set tariffs and fine or

[92] See Annex A

[93] For instance, in the case of interconnection regimes, if incremental cost accounting is mandated a score of 1 is assigned to the indicator. However, if only there is an obligation to inform interconnection tariffs under a competition law a score of 0 is assigned.

[94] Section 1 (40%), Section 2, 3 and 4 (20%) each one; Section 2 (40%), Section 1, 3 and 4 (20%) each one. Section 3 (40%), Section 1, 2 and 3 (20%) each one. Section 4 (40%), Section 1, 2 and 3 (20%) each one.

penalize operators, and (iv) transparency and participation in the regulatory process. The last dimension is whether the creation of the regulatory body (or the separation of the operating and regulatory activities) is backed by law or some norm (presidential decree, etc). Index dimensions were weighted and summed by assigning equal vale to every component; i.e., the first and third dimensions, with just one component, have a weight of about 16.6% each, as does each of the four components of the second dimension. The index reflects continuous growth to the extent that countries adopt new regulatory legislation; unfortunately, the index will always show increases unless the new legislation rules out some of the criteria already in place.

Warren (2000) developed a Policy Index aimed at measuring the impediments to trade and investment in telecommunications services. The author defines five sub-categories that will form the policy index: 1) MA/Trade: captures policies that discriminate against all potential entrants seeking to supply cross-border telecommunications services, 2) MA/invest (fixed): captures policies that discriminate against all potential entrants seeking to supply fixed network services via investment in the country at issue; 3) MA/invest (mobile): measures policies that discriminate against all potential entrants seeking to supply cellular mobile services via investment in the country at issue; 4) NT/trade: captures policies that discriminate against potential foreign entrants seeking to supply cross-border telecommunication services, and 5) NT/Invest: measures policies that discriminate against potential foreign entrants seeking to supply fixed or mobile telecommunication services via investment in the country at issue (see Appendix III).

(THIS FOLLOWING SECTION IS IMPOSSIBLE TO FOLLOW; NEED BULLETED LISTS OR SOMETHING TO MAKE IT EASIER FOR A READER TO UNDERSTAND)Following on Warren's analysis, Lim et al. (2009) measured the height of barriers to trade and investment in the Telecommunications industry in the Asia Pacific Economic Cooperation (APEC) countries. The authors rank the countries in the region using the methodology proposed by Warren (2000)[95]. They also develop a regulatory principle index using information of the WTO. This index is composed of five sections[96]: competitive Safeguard (specifies the prevention of anticompetitive activities such as cross subsidization, use of information obtained by competitors, and withholding of technical or commercial information(Yes=1, No=0)), interconnection policy (According to the WTO, interconnection with the major supplier should be made available at any technically feasible point in the network, under nondiscriminatory terms, conditions and fair quality. (Yes=1, No=0)), universal service index (1 if a country has a definition of Universal Service, 0 if it does not[97]), Licensing (if the market entry requires a “notification” a score of 3 is assigned, 2 if a “registration is required, 1 if an “authorization” is required, and 0 if a license is required) and Independent Regulator (if the NRA is separated from the ministry and telecommunications

[95] See article 24
[96] See Gutierrez (2003)
[97] If the US obligations are allocated on a competitive basis, the authors assign a score of 1, 0.5 if they are assigned to all operators and 0 if they’re assigned only to the incumbent or to some operators. If US is provided below cost a 0 score is assigned, 1 otherwise. Finally, if the cost of universal service comes from the government a score of 1 is assigned, 0.5 if US is financed by a combination of government and operators and 0 if it is solely financed by operators.

operations, it is a collegial body and it is autonomous in decision making a score of 1 is assigned, 0 otherwise; If the NRA is created by law, a score of (1) is assigned, and a score of 0 otherwise; If the NRA reports to the legislature or parliament, a score of (1) is assigned, and a score of (0) if not; If the NRA has a multi-sector jurisdiction a score of (1) is assigned and a score of (0) otherwise; If the existence of the NRA is at least two years, a score of (1) is assigned, (0) otherwise; percentage of the NRA's budget funded by the government. (Scale from 0 to 1)).

After obtaining each section score, the index is calculated assuming equal weights and normalized to a 0-1 scale. The main conclusion is that developed countries in the APEC region do not always have a higher level of market liberalization than the developing economies when measured in terms of markets access, national treatment and/or regulatory principles. In fact, some developing countries are more open than their developed counterparts in some aspects.

In reviewing the literature of measurement of regulatory and policy environments, several conclusions can be drawn. The development of regulatory indices presents the first analytical challenge of a policy impact study since, while there are several readily available objective metrics measuring sector performance (adoption, pricing, capital investment, productivity), the measurement of regulation requires the researcher to deal with implicit subjectivity. For instance, let's analyze question 99 of the ECTA scorecard. It asks whether sub-loop unbundling is used in a country. If the answer is yes the highest weight is awarded, zero otherwise. Then, in order to construct the index, a weight is assigned. As we can see there are two stages that are susceptible to subjectivity, first when deciding what is a "good policy" and then deciding the weight to be assigned to a policy.

This is because the available indices try to measure the level or intensity of regulation in a country. While the Regulatory Density Index is more focused than the ECTA Scorecard, it has the same subjectivity problem. If one wants to analyze if a policy relates positively or negatively to performance one cannot start assuming ex-ante the effect of a policy. Therefore, to evaluate the policy impact probably the more reliable approach would be to utilize discrete regulatory variables rather than a policy/regulatory index[98]. On the other hand, the index is particularly useful to assess, in a comprehensive manner, the state of policy development in a country and, in consequence, assert the impact on the development of ICT. Therefore, it would be recommended to use an index when analyzing a set of policies or regulations, but when trying to find out individual effects it is recommended to consider each policy or regulation individually.

Furthermore, each of the five indices reviewed above have specificities, as depicted in Figure 1.

[98] Imagine an index with two variables. We can only estimate the effect of the index on the dependent variable. We cannot retrieve individual effects. (similar to the reduced form Vs. structural form problem)

Figure 1. Specificity of Regulatory Indices

	ECTA SCORECARD	REGULATORY DENSITY	REGUL	POLICY INDEX	HEIGHT OF BARRIER
		Zenhausern et al. (2007)	Gutierrez (2003)	Warren (2000)	Lim et al. (2009)
Institutional Framework	X		X		
Regulatory Framework	X	X		X	X
Trade and FDI regulation				X	X

ECTA is more focused in assessing the regulatory and institutional frameworks, while REGUL measures institutional domains, Regulatory Density focuses on the regulatory framework and the Policy Index and Height of Barriers address trade restrictions primarily with a spill-over on regulatory framework. As a result, a comprehensive index will have to combine all three areas. We will therefore build a composite index, which combines elements of all four in terms of the three areas of focus. In order to deal with the subjectivity of weightings, we will rely on the robustness test conducted by Zenhausern et al. (2007).

3. Assessing Policy Causality in Broadband Adoption:

The study of policy impact on broadband diffusion has primarily emphasized the assessment of the relative importance of service-based versus platform-based competition with a focus on the U.S., the EU, the OECD and the world. Eleven studies have been analyzed with the objective of synthesizing results, drawing analytical issues and distilling methodological best practices:

- U.S.: Ford and Spiwak (2004),
- North America: Hazlett et al. (2008),
- Europe: Distaso et al. (2006), Waverman et al. (2007),
- OECD: Bauer et al. (2004); Cava-Ferreruela et al. (2006); Wallsten (2006); Boyle et al. (2008); Bourras et al. (2009), and
- World: Garcia Murillo (2005); Lee et al. (2007).

Figure 2. Summary of Selected Articles

Authors	Sample and period	Econometric Approach	Dependent variable	Policy and Regulation												Key findings
				LLU	Bit stream	Different Platforms	Density	Market Competition	Government Funding	Cable-Telco Ownership	Privatization	Liberalization	Separate Regulator	Rights of way and digging	Regulation Index	
Bauer et al (2004)	30 OECD countries (2001)	OLS	(i)Broadband penetration	X					X	X						Competition and policy regimes seem not to have an impact on broadband penetration.
Ford et al. (2004)	USA	Minimum Logit Chi-Square ("MLC") with weighted least squares	(i)Universality of access (ii) Competitive access to broadband services	X			X									Both broadband availability and competitiveness appear to be driven primarily by rural population, time, and unbundled loop prices; Higher loop prices reduce both the universal and competitive availability of broadband services
Garcia-Murillo (2005)	100 countries (2001)	Logit model for (i) OLS for (ii)	(i)Availability of Broadband (ii)Broadband Penetration	X			X	X			X				X	Unbundling an incumbent's infrastructure only results in a substantial improvement in broadband deployment for middle-income countries, but not for their high income counterparts
Distaso et al (2006)	15 countries (2000-2004)	PD FE & RE& IV	(i)Broadband Penetration	X		X		X						X		Competition between different platforms seems to be one of the main drivers of broadband uptake and as this level of competition raises, it also raises the positive effect of a reduction of the price of LLU on broadband uptake
Cava-Ferreruel, Alabau-Muñoz (2006)	30 OECD countries	Reduced Form. Multivariate Regression Analysis (Technique not specified)	(i)DSL subscribers by 100 inhabit (ii)CATV subscribers by 100 inhabit	X		X	X	X								Availability of DSL access networks is dramatically higher for countries with competing broadband infrastructures (an average of 10 times greater); When the broadband market is mature enough to have a high level of broadband coverage, the affordability is the key drivers for both DSL and cable modem adoption

Wallsten (2006)	30 OECD countries (1999-2003).	PD FE	(i) Broadband subscribers per capita	X	X		X									Population density matters: it is positively correlated with broadband penetration and with connection speeds; Full local loop unbundling is not obviously correlated with broadband penetration; Subloop unbundling is robustly negatively correlated with broadband penetration; Commingling collocation is generally positive, virtual collocation negative, and regulatory approval for collocation charges negative.
Waverman et al. (2007)	53 Obs – 12 Countries 2002-2006	SUR (equation 1-2) OLS (equation 3)	(i)Share of all alternative access technologies (ii)Share of competitor DSL offered over the PSTN (iii) Total Broadband Penetration	X	X											More intense access regulation, as measured by a lower LLU price, stimulates intraplatform competition and may cause the overall broadband market to expand. However, it also causes a substitution away from broadband offered over alternative access platforms to copper-based platforms. If the substitution effect dominates the market expansion effect, the result would be a loss in investment in access platforms.
Lee et al (2007)	110 countries (2002-2006)	Multivariate Regression Analysis (Technique not specified) ANOVA for LLU effect	(i)Broadband penetration	X	X	X										Platform competition, LLU, broadband speed, information and communication technology use, and content contribute to global broadband adoption. The impacts of platform competition are strong when market share of dominant technology and non-dominant technology is similar.
Boyle et al (2008)	24 OECD countries (2002) – 30 OECD countries (2005)	Panel data - clustered standard errors	(i)Broadband penetration	X		X										the contribution of local loop unbundling to the level of national broadband uptake is materially very small The technology diffusion effect should be considered

Hazlett et al. (2008)	USA	OLS and tests for structural break	(i) DSL subscribers (ii) Cable modem									X				After the partial DSL deregulation (2003) econometric evidence shows that the changes in regimes influenced the growth in DSL penetration, while there is no econometric evidence to confirm that full deregulation (2005) promoted the DSL penetration growth seen in the data.
Bouras et al. (2009)	31 firms in 25 countries	PD RE & FE	(i)operating income to sales ratio (ii)return on sales ratio (iii)return on assets ratio (iv)return on equity ratio (v)real sales (vi)number of access lines in service (vii) real sales per employee (viii) average number of access lines in service per employee (ix) number of employees (x) real capital expenditures (xi) capital expenditures to sales ratio (xii) capital spending to total assets ratio \ (xiii) level debt to total assets ratio					X			X	X	X			Privatization is significantly related to higher profitability, output and efficiency, and with significant declines in leverage Competition significantly reduces profitability, employment and, surprisingly, efficiency after privatization while creation of an independent regulatory agency significantly increases output Mandating third party access to an incumbent's network is associated with a significant decrease in the incumbent's investment and an increase in employment Retained government ownership is associated with a significant increase in leverage and a significant decrease in employment, while price regulation significantly increases profitability.

Bauer et al. (2004) was one of the first studies that explored the main factors influencing broadband penetration at an aggregate, national level. The authors used cluster analysis to identify homogenous subgroups of countries with similar policy characteristics across three areas - unbundling, the separation of cable and telephone company ownership and the availability of government funding to support broadband deployment- to reduce the number of independent variables. Cluster analysis yielded three groups: cluster 1 included U.K., U.S.,

Austria, Netherlands, Spain, Japan, Korea, Canada, Ireland, Italy, Sweden, Australia, Denmark, Hungary, while cluster 2 comprised New Zealand, Switzerland, Turkey, Poland, Slovak Republic, Belgium, Greece, Iceland, Czech Republic, Germany, and cluster 3 included Norway, Portugal, Finland, France, Luxemburg, Mexico. Membership in a cluster was translated into a dummy variable.

Having defined these clusters, the authors used a supply-and-demand framework and derived a reduced form model, which was used in the econometric analysis. The supply side was modeled as a function of price, competition and cost conditions and demand was expressed as a function of price, price of substitutes, income and preparedness. The reduced form was estimated using OLS. While the authors mentioned that they would have preferred the use of a fixed-effects data panel, they relied on a simple cross-sectional design based on observations for the year 2001. This technique did not allow controlling for the existence of unique national conditions. The dependent variable was broadband penetration, while the independent variables were 1) price of broadband, 2) price of dial-up service, 3) income, 4) preparedness Index, 4) competition, 5) population density and 6) a dummy reflecting policy regime. The statistical analysis revealed that the combination of policy factors presented in the first cluster had a positive but not significant impact on broadband development. In contrast, the combination characteristic for the second group was detrimental to broadband development, although the effect also was not statistically significant

The authors concluded that competition does not have a statistically significant effect on penetration. Moreover, it could have a negative effect, implying that more intense competition in the telecommunications market correlates with a lower broadband penetration rate. This finding, while contradicting later studies of broadband diffusion, could also point to the oligopolistic structure of broadband in which a more open market structure could lead to market fragmentation and, potentially, lower deployment.

Ford and Spiwak (2004) evaluated the influence of unbundling on both the general availability of broadband service as well as whether the service is provided competitively at a state level for the United States of America. The authors modeled two equations expressing the dynamic of universality of access[99] and competition[100]. Each variable was expressed as a function of the same exogenous variables (UUL price, ULL cost, income, density and time). The authors conducted the estimation of each equation using Minimum Logit Chi-Square ("MLC")[101] with weighted least squares because the regression disturbances were not homoscedastic, White's robust standard errors were used to compute the t-statistics. Finally, to test if the specifications were correct, a Ramsey Regression Equation Specification Error Test (RESET) was performed. The dependent variables considered were: 1) universality of access: percentage of zip codes in a state that have at least one provider of broadband services, and 2) competitive access to broadband service (percentage of zip codes in a state that have at least four providers of

[99] Percentage of zip codes with at least one broadband provider
[100] Percentage of zip codes with at least four broadband providers
[101] They use this specification because both independent variables are expressed in percentages.

broadband services). The exogenous variables were: 1) per capita income, 2) percent of rural population, 3) number of large cities, 4) dummy variables for time, and 5) dummy for Bell Company region.

The study found that (i) both broadband availability and competitiveness appear to be driven primarily by rural population, time, and unbundled loop prices, and that (ii) higher loop prices reduce both the universal and competitive availability of broadband services.

Garcia-Murillo (2005) studied two questions: (i) how unbundling policies affect decisions to offer broadband access to the internet and (ii) which factors contribute to the adoption of broadband. A two-stage analysis was used. First the factors that affect the availability of broadband services in a country were identified. This analysis used a logit regression, where the probability of broadband availability was represented as a function of GDP per capita, population percentage of internet users, illiteracy rate, broadband competition, privatization and unbundling. The purpose of the first logit regression was to determine whether market conditions and government actions affected the availability of broadband independently of the number of people subscribing to the service. Second, a set of models relied on OLS regression analysis aimed at identifying the factors influencing the number of broadband subscribers. In this model the number of subscribers was a function of GDP per capita, population, price, competition of broadband providers, percentage of internet hosts, internet users, privatization, unbundling and density. The sample of over 100 countries was divided in four types of countries: low income, lower-middle income, upper-middle income and high income. The variables that were utilized included an unbundling dummy, ownership dummies (privatized, state-owned, semi-privatized), competition dummies (monopoly, duopoly, partial competition, full competition), population density, GDP per capita, monthly price per MB, education level (Illiteracy rate / average education level of the population in years), content (number of domain name servers registered), personal computers, percent of people that have access to the Internet but not broadband, and percent of population with broadband access.

The analysis showed that unbundling an incumbent's infrastructure only results in a substantial improvement in broadband deployment for middle-income countries, not for their high-income counterparts. However, the study did not specify variables for time effects since the data considered was only for 2001 The variable representing competition did not consider level of competition; it only considered number of players in a given country. Furthermore, the author did not distinguish between inter- and intra-platform competition when trying to estimate the determinants of broadband adoption.

Complementing Garcia Murillo's study, Distaso et al. (2006) focused on the role of competition in promoting broadband adoption. The authors studied the impact on broadband adoption of policies aimed at fostering competition between platforms and policies aimed at promoting intra-platform competition (within the DSL market). They tested the results of a theoretical platform competition model based on a model of oligopoly competition between differentiated products using a static and a dynamic data panel. The hypotheses tested were three: (i) the lower the price for local loop unbundling (LLU), the higher broadband adoption, (ii) a reduction

in the price of LLU may be more effective in promoting broadband the lower inter-platform concentration, and (iii) the lower the Herfindhal indices, relative to both inter- and intra-platform concentration, the larger total broadband access.

The variables relied upon comprised broadband penetration[102], an index measuring the level of market concentration/competition[103] within the DSL technological platform, an index measuring the level of market concentration/competition across different platforms, a dichotomous variable for the rights of way and digging permits over public land (1) if they are granted by a single authority (0) if the rights of way are granted by local authorities, a dichotomous variable taking the value of 1 when operators experience delays in getting rights of way or digging permits and 0 when no delays are reported, a variable that measures the price of an unbundled copper local loop, a variable that measures the price of a leased line and the price of a 10 minute local call on the incumbent's fixed network and GDP per capita. The data set was compiled for Austria, Belgium, Denmark, France, Finland, Germany, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom.

The authors found that competition between different platforms seems to be one of the main drivers of broadband uptake and that as this level of competition rises it also raises the positive effect of a reduction of the price of LLU on broadband uptake. However, the authors did not consider a possible endogeneity problem between GDP and broadband penetration.

Cava-Ferreruela et al. (2006) also analyzed the factors that could affect the supply and demand of broadband. The authors specified two equations to explain broadband supply and broadband demand. The variables used to estimate the supply side were infrastructure availability, infrastructure investment and market competition, while the demand side was estimated by relying on telecommunication services penetration, internet indicators, economic indicators, demographic indicators, education indicators and social indicator for thirty OECD countries.

The econometric analysis was structured into two stages. First, to identify cross-influences between independent features that could disturb a linear model for the dependant variable estimation (co linearity problems), the authors calculated Pearson bivariate correlation coefficients between a selected set of factors and the variable under study with the purpose of building an initial ranking of factors that influenced the dependent variable. Second, to assess the degree and character of the relationship between dependent and independent variables, the authors utilized a multivariate regression analysis.

Their study found that the most influential factors for broadband infrastructure supply are the economic level of the country, the existence of another platform and the demographic

[102] The number of broadband lines by the total number of access lines. The number of lines is obtained by dividing the sum of DSL, cable TV, fiber optic and satellite line. The indicator measures the number of all possible access lines that have been upgraded to transmit high-speed data.
[103] The standard Herfindhal index.

distribution of the population. The results showed that the availability of DSL access networks is dramatically higher for countries with competing broadband infrastructures (an average of 10 times greater). In addition, when the sample was divided in two groups for countries with a penetration level under 50% education levels appeared to be the key factor in developing broadband, while countries with penetration level equal or above 50% affordability of broadband access was the key factor. These results suggest that when the broadband market is mature enough to have a high level of broadband coverage, service affordability is the key driver for both DSL and cable modem adoption. A clear drawback of the adopted approach is the assumption of linear relationship between the independent and dependent variables. Another possible bias is the use of a dummy to represent technological competition[104].

Wallsten (2006) explored some of the determinants of broadband penetration and speed of available internet connections in OECD countries. This study took into account unbundling regulation, types of wholesale price regulation and types of collocation implemented. The author estimated a data panel where the dependent variable was broadband subscribers per capita and was expressed as a function of unbundling dummy variables, wholesale price regulation dummy variables**,** dummies indicating the types of collocation implemented, and a set of control variables. They also estimated two models: 1) using fixed effects to control for time trends, which is especially important given the extremely fast increase in broadband penetration over this time period and 2) country-fixed effects, which controls for country-specific factors that affect broadband penetration. The dependent variables were broadband penetration and speed, while the exogenous variables were 1) dummies for the types of unbundling (full unbundling, bitstream, and subloop), 2) dummies for the wholesale price regulation (regulatory approval for line rental charges and regulatory approval for collocation charges), 3) dummies for Collocation implemented (co-mingling, remote, and virtual), 4) main telephone lines per 100 people, 5) GDP per capita, 6) population per square kilometer, 7) price of 20 hours of Internet use, presumably dialup. The data set comprised 30 OECD countries over five years (1999-2003).

The study found that: (i) Population density matters: it is positively correlated with broadband penetration and with connection speeds. More densely populated countries have higher penetration rates; (ii) Full local loop unbundling is not obviously correlated with broadband penetration; (iii) Subloop unbundling—the most extensive type of unbundling studied here—is robustly negatively correlated with broadband penetration, and (iv) comingling collocation is generally positive, virtual collocation negative, and regulatory approval for collocation charges negative.

Waverman et al. (2007) studied the impact of access regulation on investment in access infrastructure[105]. Using an unbalanced panel data, the authors sought to capture two effects of

[104] 1if there are two or more technologies in the market, 0 if there is only one technology. This representation could lead to a bias, for example in Germany where Broadband infrastructure is overwhelmingly provided by XDSL would be considered as a place where there is technological competition.

[105] Including either alternative or new access platforms (Investment in infrastructure that offers genuine last-mile alternatives to the existing copper-wire network of the incumbent telecommunications operator.

a change in the intensity of access regulation, as measured by the price of unbundled local loops. These were (a) the substitution between LLU-based broadband and broadband offered over alternative access platforms, and (b) the impact of a change in the LLU price on the size of the overall broadband market. The authors developed a two-equation system for the share of all alternative access technologies and the share of competitor DSL offered over the PSTN. This system was estimated using Seemingly Unrelated Regressions (SUR). Then a third equation, Total Broadband Penetration, was estimated using Ordinary Least Squares (OLS). The variables relied upon included alternative access (sum of all broadband lines offered through alternative access infrastructure — this included competitor and incumbent cable, all fiber, WiMax, WiLL, and competitor DSL offered over alternative networks), competitor DSL (competitor lines offered over the PSTN, or alternatively sum of shared access and fully unbundled lines, excluding Bitstream and simple resale, incumbent DSL (DSL provided over incumbent lines and retailed by the incumbent), total broadband penetration (sum of alternative access, competitor DSL and incumbent DSL per 100 population), LLU (annual price for a fully unbundled local loop), Bitstream (dummy variable which equals 1 if Bitstream access is available and is being used, 0 otherwise), LLU Years (years since LLU was first implemented), ratio (ratio of Internet households to internet-ready cable plant in 2003; the higher this variable, the higher is the incremental cost to expanding cable access networks) and the Hirschman-Herfindahl Index computed from the shares of the different access platforms in total broadband. The dataset is derived for 12 European Countries.

The main findings of this study were as follow:

(i) lower local loop prices cause a strong substitution from broadband offered over alternative access platforms towards LLU-based broadband offerings. This substitution ultimately results in substantially lower investment in these alternative access platforms.

(ii) A reduction of 10 percent in LLU price causes an 18 percent fall in the subscriber share of alternative infrastructure. Thus, intense access regulation (as measured through the LLU price) weakens facilities-based competition and the benefits that such competition delivers.

(iii) This fall in subscriber levels has the impact of reducing investment in alternative access platforms in both short term and the long term. This study could contain an endogeneity problem for LLU price.

Boyle et al. (2008) conducted a study to assess the results of a study commissioned by the OECD that found a statistically significant effect of unbundling on broadband uptake (OECD, 2007). The authors re-estimated the OECD data using OLS with clustering standard errors[106] in order to verify the significance of the OECD's study results. The dependent variable was broadband connections per 100 population while the independent variables considered were number of years since the implementation of local loop unbundling (measure of unbundling presence), monthly price per megabit-second of DSL (in $US PPP), share of the population aged

[106] Arellano (1987) and Peterson (2007).

between 35 and 44 years, percentage of the population defined as urbanized, non-DSL connections as a percentage of total broadband connections (measure of broadband competition), and the number of years that the broadband technology has been available for each country. Data was compiled for 24 OECD countries in 2002 and 30 OECD countries in 2005. This study properly accounted for the error structure of the data and found that the statistical significance disappears. The authors concluded that the OECD report could not be used to justify the view that local loop unbundling leads to greater broadband uptake. Moreover, this study concluded that the technology diffusion effect should be considered. To deal with this, it included in the specification a variable that controls for the time that broadband has been available in a particular country to locate a country in a point of the technology diffusion curve.

Hazlett et al. (2008) studied the impact of the regulatory framework on broadband development in the U.S. The authors divided the regulation periods in three: 1) regulated DSL with line sharing obligations (prior 2003), 2) DSL partially deregulated (ex-line sharing) (2003-2004) and 3) unregulated cable/unregulated DSL (since 2005). To test if there was an impact of the deregulation process on efficiency the authors explained that the following hypotheses could not be rejected:

(1) pre-1Q2003: DSL subscriber growth will exceed Cable modem subscriber growth.- The authors used descriptive statistics and expert opinions to validate this hypothesis.
(2) 1Q2003-4Q2006: DSL subscriber growth will decline from trend. - The authors used a test for structural break of the time series to test if the growth in DSL penetration is a result of deregulation.
(3) 3Q2005-4Q2006: DSL subscriber growth will further decline from trend. - The authors used a test for structural break of the time series to test if the growth in DSL penetration is a result of deregulation.

The variables utilized were DSL and cable modem subscribers in Canada and the U.S.
The evidence in U.S. broadband markets suggests the efficiency gains from deregulation. After the partial DSL deregulation (2003), econometric evidence shows that the changes in regimes influenced the growth in DSL penetration, while there is no statistical evidence to confirm that full deregulation (2005) promoted the DSL penetration growth seen in the data. The authors found that after 2003 something happened (a structural break) and this situation affected positively DSL penetration. The problem with this methodology (time series-structural change) is that anything could have affected DSL penetration but the authors are attributing this effect to the variable that they want to test (2003 deregulation). While they controlled for cable modem subscribers and time trend, one cannot discard an exogenous factor or an omitted variable.

Lee et al. (2008) explored influential factors of global broadband diffusion by examining adoption factors – such as platform competition, information and communication technology (ICT) use, content, broadband speed, income, population density, education, price, and local loop unbundling (LLU). The paper examined influential factors of global broadband adoption; it employed regression analysis and one-way ANOVA (Analysis of Variance). A total of 110 observations were employed for multiple regression analysis and 159 observations were used

for one-way ANOVA. An interesting point is that in the multiple regression analysis the authors exclude the LLU variable because they considered that platform competition and LLU are not mutually exclusively policy tools. In order to analyze the LLU effect, the authors use a one-way ANOVA. The dependent variable was broadband penetration rate while the independent variables comprise platform competition[107], broadband price, broadband speed, income, ICT use[108], education, population density and content[109]. Data was compiled for 110 countries.

The findings in the paper showed that platform competition, LLU, broadband speed, information and communication technology use, and content contribute to global broadband adoption. The impact of platform competition is strong when market share of dominant technology and non-dominant technology is similar. This study did not differentiate between the various types of LLU and their respective prices. The study used only cross-sectional and did not consider time variables.

Bouras et al. (2009) developed a methodology for identifying best practices followed by various countries worldwide for supporting broadband growth. Using the results of research about factors affecting broadband penetration their study quantified them, locating the countries worldwide that followed best practices.

Reviewing the literature the authors considered at least five main factors that affect broadband growth: regulatory framework, structural changes that take place in the information and communications technology markets (e.g. increase of competition, privatization of public organizations, market liberalization,etc.), changes of broadband services and of their use (e.g., VoIP, mobile telephony, 3G, WLAN, WiFi, WiMAX, digital television), users' need for fast content access, the affordability and, E (electronic)-readiness and, in general, the technological level of a country. Then, using the above factors as a base, the authors elaborated two indices: (a) the best practice index, which indicates that a country followed some of the best practices worldwide for supporting its broadband growth and (b) the good practice index, which indicates that a country followed some of the good practices worldwide. After calculating the indices, they defined a threshold; the average score of each sample, in order to determine what countries can be categorized as followers of best or good practices. The countries considered were Korea, U.S., Japan, Canada, Denmark, Sweden, Finland, Netherlands, Belgium, Norway, U.K., Austria, Australia, Germany, France, Ireland, Portugal, Italy, Spain, New Zealand and Greece.

The main results are:

(i) Denmark, United States, Japan, Canada, Republic of Korea and Sweden have followed best practices

(ii) Policies applied by the U.K and the Netherlands only came up as good practices and

[107] (100-|market share of dominant technology – market share of non-dominant technologies|)
[108] Estimated PCs per 100 inhabitants
[109] Internet hosts per 100 inhabitants

(iii) Norway, Belgium and Finland are not presented either as best practices or as good practices.

What have all the studies reviewed found? With very few caveats, platform-based competition appears to be the key variable explaining broadband deployment. Platform-based competition is one of the main drivers of broadband uptake, as concluded by Distaso et al. (2006), Cava-Ferreruela et al. (2006), Boyle (2008), Wallsten (2006) and Garcia-Murillo (2005) (although in this case for high income countries). Lee et al. (2008) determine that the impact of platform-based competition is stronger when the share of technologies reaches parity (this related to competitive intensity). Waverman et al. (2007) determined that unbundling tends to weaken facilities-based competition and reduce infrastructure investment.

Conversely, most studies provide limited evidence on the importance of LLU in fostering broadband adoption. There is a small, statistically insignificant positive effect (Distaso, et al., 2006; Cava-Ferruela et al., 2006), and a small effect which is neither consistently positive nor consistently significant (Wallsten, 2006). Bauer et al. (2004) was the only study that failed to identify an impact of competition policy on broadband penetration, although this could be related to the time at which the research was conducted relying on very preliminary data sets, while Ford and Spiwak (2004) determined that unbundling prices had a positive impact on broadband availability.

Furthermore, the review of these eleven studies raises five methodological issues that will need to be addressed in our statistical work. It is critical to recognize the endogeneity problems attached to the study of policy impact. At least one study indicates the existence of endogeneity: In Waverman et al. (2007) if regulators set LLU prices not neutrally, but based on current and target levels of penetration or competition to the incumbent's DSL offerings, then this variable is endogenous. In such an event, both OLS and SUR would yield biased estimates. In addition, we believe co-linearity to represent a potential problem, resulting in a situation where two explanatory variables could be related, although one of them is significant while the other is not. For example, in Walsten (2006) the majority of the countries that have implemented full unbundling have also implemented subloop or bitstream. The same goes for the collocation variables. In Ford and Spiwak (2004), the variable price and cost exhibit a co-linearity problem, because most of the price regulation is linked to the establishment of LRIC. In Bauer et al (2005), in more mature markets, the variable price would be reflecting a competitive situation since in this stage of the market companies compete in prices. This may not be the case in a market in its early stage of development, where carriers may compete using other dimensions, such as service quality, initial free trials and the like, without reducing the eventual service price.

Thirdly, it is important to consider a problem that usually occurs in data panel estimation. Residual clustering in panels can result in OLS standard errors containing significant bias, and hence in t-statistics that are considerably overstated. As pointed by Boyle et al. (2008) in their assessment of the OECD (2007) study, the potential for time series clustering of residuals by

country is high, given that 2005 broadband observations for each country are likely to be related to their 2002 counterparts.

Fourth, it is important to recognize the non-linear relation nature of the relationships. For example, Cava-Ferreruela et al. (2006) acknowledged that the underlying causality is too complex to be modeled using a simple linear relation among variables.

Fifth, it is critical to define variables that address performance not only of a static nature but also dynamic one. For example, Ford and Spiwak (2004) did not take into consideration quality and speed or the effect of platform competition (dynamic effects). The authors defined competition as the number of broadband providers without raising the question whether unbundling provides a faster broadband or a constant increment in competition or availability. Nevertheless with data being only for two years, it is difficult to answer this last question.

Several methodological implications for our statistical study can be drawn from this assessment:

- Endogeneity: The most common approach is through instrumental variables (IV) techniques. The most common IV estimator is Two Stage Least Squares (2SLS)[110].
- Co-linearity: First, a Pearson correlation analysis should be conducted to evaluate the strength of correlations among independent variables. Second, to test the persistence of a problem, various specifications should be compared.
- Residual clustering: Use Arellano (1987) and Peterson (2007) methodology to estimate robust standard errors. This will eliminate the bias in standard errors that would overestimate t-statistics.
- Non-linearity: Use Non-Linear Least Squares, GMM or MLE.
- Dynamic efficiency: Introduce a proxy for facilities based-competition and time trend variables. This will allow us to isolate inter-platform benefits.[111] Additionally, the evolution of broadband speed would serve as a proxy of the quality of broadband provided.

4. Assessing Policy Causality in Wireless Adoption and Pricing:

We have identified two studies that research the policy impact on the diffusion of wireless telephony.

[110] A good instrument is a genuinely exogenous variable that is strongly correlated with the potentially endogenous regressor. One has to be sure that the instrument only influences the dependent variable through the potentially endogenous independent variable.
[111] Inter-platform competition is associated with a dynamic efficiencies (See Katz, 2009)

Figure 3. Summary of Selected Articles

Authors	Sample and period	Econometric Approach	Dependent variable	Policy and Regulation												Key findings
				LLU	Bit stream	Different Platforms	Density	Market Competition	Government Funding	Cable-Telco Ownership	Privatization	Liberalization	Separate Regulator	Rights of way and digging	Regulation Index	
Grzybowski (2005)	15 EU countries (1998-2002)	Reduced Form PD RE-FE	(i)Penetration of mobile services (ii)Price of mobile services			X		X				X				Liberalization of fixed telephone lines has a negative impact on prices and a positive impact on the demand for mobile services The introduction of mobile number portability has a negative impact on prices
Maiorano and Stern (2007)	30 countries (1990-2004)	Structural System of equations – PD FE + AB & PD-3SLS	(i)Penetration rate (ii)GDP per capita (iii)Regulatory governance								X	X	X			The existence of an autonomous infrastructure industry regulator increases penetration rates for mobile telecommunications in developing countries Neither the existence of a sector law nor the funding of the regulator through license fees had any apparent statistically significant impact on mobile penetration

Grzybowski (2005) studies the impact of regulatory policy on prices and demand for mobile telecommunications services across the European Union. The importance of this study is that the author tries to estimate the variables driving price differentials of mobile services across the European Union. The data is shown as a panel of 15 EU countries[112] over 1998-2002. The endogenous variables are penetration of mobiles and price of mobile services, while the exogenous ones are divided in three categories: a set of regulatory variables (permission of airtime resellers, implementation of number portability and liberalization), a set of cost determinants variables (designation of SMP[113] in interconnection market, 10-year government

[112] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and the UK.
[113] Significant Market Power

bond yield, hourly labor compensation costs in industry in $US PPP and electricity prices for industrial users in $US PPP, and dummies to capture the effect of time) and a set of miscellaneous variables (penetration of mainline, number of MVNO, inverse number of operators, GDP per capita in $US PPP, population size and the first time passed since entry of the first digital operator in years).

The author estimates a reduced form model. The two equations in the reduced form describe first the penetration of mobile services (demand side) and secondly the price of mobile services (supply side). Finally, the author estimates the demand and the supply sides using panel data analysis with fixed and random effects. The main conclusions of this study are: (i) liberalization of fixed telephone lines has a negative impact on prices and a positive impact on the demand for mobile services and (ii) the introduction of mobile number portability has a negative impact on prices.

Maiorano et al. (2007) study the relationship between regulation and performance in the mobile telecommunications sector. In this study the authors try to separate the impact of regulation from the potential indirect effects due to country institutions. The information is shown as a panel[114] of 30 low and middle-income countries over 1990-2004. The endogenous variables are the penetration rate of mobile telecommunications, GDP per capita and a measure of regulatory governance[115,] while the exogenous ones are average price of mobile telecommunications services, average price of fixed telecommunications services, population density, the telecommunications investment/GDP ratio, a proxy for country institutions, a proxy for human capital, a measure of physical capital, the ratio between trade and GDP, the country income level, and multilateral lending. The sample comprises 30 countries with a level of GDP per capita in constant dollars between USD 300 and USD 8,000.

The authors develop a structural system of equations to be estimated. These equations represent the dynamic of penetration rate, GDP per capita and regulatory governance. First, each equation is estimated individually using fixed effects, random effects and instrumental variables. Secondly, a dynamic specification is developed for each equation and the estimated using fixed effects and then the Arellano and Bond estimator. Finally, the equations are estimated as a system of simultaneous equations estimated by three-stage least squares. The main conclusions of the study are: (i) there is some evidence that the existence of an autonomous infrastructure industry regulator increases penetration rates for mobile telecommunications in developing countries; on the other hand, neither the existence of a sector law nor the funding of the regulator through license fees had any apparent statistically significant impact on mobile penetration (ii) there is a contribution of a more widespread mobile telecommunications infrastructure to higher levels of GDP per capita.

[114] Unbalanced panel of yearly data

[115] These include: whether the country has passed a framework law for the telecommunications sector; the country has established a regulator as a separate entity from the policy maker; the regulator is not funded by the Government's budget, and the years since the creation of the regulator

Both studies conclude that the policy framework has an impact on the diffusion and pricing of wireless services. In particular, competition, number portability and an autonomous regulatory agency have an impact on prices and penetration. On the other hand, a sector law or funding of the regulatory agency through license fees does not have an impact on wireless adoption.

The review of these studies also raises methodological issues to be addressed in our statistical work. First, as Maiorano et al (2007) note, investment in telecommunications infrastructure can contribute to economic growth directly by an increase in production and, indirectly, by facilitating communications between firms, thus increasing their production possibilities. This raises the question of considering income as an endogenous or an exogenous variable. If income is an important determinant of penetration not only for mobile services but also for the entire telecommunications industry, the failure to treat it as endogenous can readily lead to biased results in a reduced-form equation. Second, in the case of Grzybowski (2005), the author assumes that the penetration of mainline and the number of MVNO are exogenous. We have doubts about these assumptions, mainly because in mature markets a substitution mobile-fixed effect could exist.

To deal with endogeneity an Instrumental Variable estimator is recommended as noted in the previous section.

5. Assessing Policy Causality in Wireline Development and Telecommunications Sector Performance:

Seven studies researching the policy impact on the development of wireline services and overall telecommunications sector performance were identified.

Figure 4. Summary of Selected Articles

Authors	Sample and period	Econometric Approach	Dependent variable	Policy and Regulation												Key findings
				LLU	Bit stream	Different Platforms	Density	Market Competition	Government Funding	Cable-Telco	Privatization	Liberalization	Separate Regulator	Rights of way and	Regulation Index	
Wallsten (2001)	30 countries (1984-1997)	Reduced form using PD-FE	(i)Mainline penetration (ii)Connection capacity (iii)Payphone penetration (iv)Employees per hundred lines (v)Price of 3 minute local call			X	X				X		X			Competition is significantly associated with increases in the per capita number of telephone mainlines, payphones, and connection capacity, and with decreases in the price of a local call. Privatization by itself is significantly associated with a decreased capacity but when combined with the existence of a separate regulator is significantly associated with increases in connection capacity and labor efficiency, and

															mainlines per capita
Gutierrez (2003)	22 LA&C (1980-1997)	PD FE & RE+ AB	(i)Teledensity (ii)Employees per main lines				X	X			X		X		X	A better regulatory framework will have greater network deployment. Competition and privatization (ownership) are associated positively with the level of network and with main line per employee for the whole sample. Neglecting the effect of lagged dependent variables may distort or overestimate the effect of all the variables, including reform variables
Li et al. (2004)	177 Countries	OLS and 2SLS to test for robustness	(i)Telecom investment per capita (ii)Local price index (iii)Output index (iv) Labor productivity (v)Capital stock (vi)Fixed density (vii)Mobile density					X	X			X				Full privatization and competition have a significant positive effect on investment Full privatization has an important positive effect on increasing fixed-line and mobile densities, while, competition only has a significant effect on mobile density. Full Privatization tends to increase the industry output but also prices. Privatization increases labor productivity by almost 50% and competition by almost 10%.
Waverman et al. (2006)	15 EU countries (1997-2003)	Pooled OLS	(i)Per minute rate charged for call termination on incumbent fixed line networks					X				X		X		Public ownership of the incumbent positively affects incumbent's interconnection rates. The presence of institutional features enhancing regulatory independence from the government mitigates this effect
Grzybowski (2007)	15 EU countries (1998-2002)	Reduced Form PD RE-FE and IV	(i)Price of fixed-line services	X				X				X				Liberalization of fixed-line telephony and regulation, such as, implementation of carrier pre-selection and number portability had a negative impact on residential prices. Regulation decreased average price levels across the EU in the years 1998-2002 by about 8.2%.
Grajek et al (2009)	70 firms, 20EU countries (1997-2006)		(i)Intensity of regulation (ii)Incumbent's investment (iii)Entrant's investment			X		X								Access regulation discourages investment by incumbents and individual entrants even as entrants' total investment increases. Endogeneity of regulation matters empirically. In terms of regulatory determinants, regulatory responses to infrastructure investments differ between incumbents and entrants. Whereas access regulation is not affected by entrants' investment, regulators toughen access regulation in response to increased investment by incumbents.

Wallsten (2001) undertook an econometric analysis of the effects of telecommunications reforms in developing countries. The author used a panel dataset of 30 countries in Africa and Latin America from 1984 through 1997. He employed a fixed-effects model to control for unobserved country specific factors and corrected the standard errors for serial autocorrelation. He estimated two equations, first the telecom indicators as a function of the number of mobile operators not owned by the incumbent, a dummy indicating whether the incumbent was privatized, a dummy indicating the existence of a separate regulator and a vector of control variables. In the second equation, to explore further effects of regulation, the author allowed the interaction of the regulation dummy with the privatization dummy and with the number of competitors. The variables utilized comprised primary telecommunication indicators (number of mainlines per capita, number of payphones per capita, network connection capacity per capita, telecom employees per main line, and price of a three minute call), privatization (dummy equals one beginning the year the firm was privatized, if ever), competition (number of wireless operators in the country not owned by the incumbent), and regulation (dummy variable indicating whether the country has a separate telecommunications regulatory agency not directly under the control of a ministry). The control variables included GDP per capita, population, percent of the population living in urban areas, a dummy variable indicating whether the country passed telecom reform legislation, a dummy variable indicating whether a World Bank telecommunications project was active in the country-year, net World Bank aid as a percent of GDP, exports as a share of GDP, and a variable measuring the risk of expropriation. The datasets were developed for the following countries Botswana, Cameroon, Cote d'Ivoire, Ghana, Kenya, and Malawi. Morocco, Mauritius, Mozambique, Nigeria, Senegal, Tanzania, Uganda, South Africa, Zambia, Argentina, Brazil, Bolivia, Chile, Costa Rica, Colombia, Dominican Republic, Ecuador, Guatemala, Jamaica, Mexico, Panama, Paraguay, Peru, Uruguay, and Venezuela

The author found that competition is significantly associated with increases in the per capita number of telephone mainlines, payphones, and connection capacity, and with decreases in the price of a local call. Privatization by itself is significantly associated with a decreased capacity but, when combined with the existence of a separate regulator, is significantly associated with increases in connection capacity and labor efficiency, and mainlines per capita. The biggest potential problem is that competition, privatization and regulation may be endogenous to reforms. That is, reforms affect telecom performance, but performance may also affect reforms. Another problem is that the dummy variable for an independent regulator is an oversimplification of telecom regulation[116].

Gutierrez (2003) examined the effect of reform on telecom performance using a regulatory index and panel data techniques to test how regulatory governance affected sector performance. This study is relevant because it endogenizes some of the main telecom reform variables. First, the author estimated a logit model, using 2SLS, to calculate the probability for competition and privatization as a function of the regulatory index as well as a number of

[116] The author didn't include a variable with type of regulation (e.g. price caps or cost-of-service)

control variables. Then, this probability was included in the estimation of the number of mainlines per 100 inhabitants and the number of employees per 100 mainlines. The variables considered included "owner" (which measured the level of privatization, with a value of 1 when government divestment of former state-owned telco operators exceeded 50% and zero otherwise), competition (which accounted for both allowing entry into basic telecommunications and the beginning of wireless telecommunications), regulation (which is an index of the regulatory framework), GDP, trade, and population density for 22 countries of Latin America.

The two equations were estimated using static and dynamic models. First, fixed effects and then using random effects. This is a first exploration of the inclusion of lagged variables in the specifications. The importance of lagged variables may be the result of an endogeneity between GDP and number of mainlines (Growth---Technology---Growth).

The study found that (i) a better regulatory framework will have greater network deployment; (ii) competition and privatization (ownership) are associated positively with the level of network and with main lines per employee for the whole sample, and (iii) neglecting the effect of lagged dependent variables may distort or overestimate the effect of all the variables, including reform variables.

Li et al. (2004) studied the effect of privatization (full and partial) and competition on a group of telecommunication performance variables. Each telecom performance variable is modeled as a function of a set of country economic indicators and telecom reform variables. The authors try to explain the same independent variables with the same set of exogenous variables. The authors include country fixed effects to represent country-specific heterogeneity. To obtain consistent standard errors for estimates, the authors take into account potential within-country serial correlation of the idiosyncratic errors by allowing for unrestricted covariance structure over time within any country. To test the robustness of their model, the authors use 2SLS and use a group of instruments to take into account that the decision to privatize or introduce competition could be endogenous, which means that these decisions could be a function of the output. The Dependent Variables are a) Telecom investment per capita, in 1998 U.S. $, b) The local price index, with local price measured as a three-minute local call (in constant 1998 U.S. $, c) The output index; real output is measured as total revenue divided by the cost of a 3-minute local phone call; the base year is 1990, when the index is set to equal one, d) The index of labor productivity, which is measured as real output per employee; the base year is 1990, when the index is set to equal one, e) The labor index, constructed based on the reported number of employees; the index is set to equal one in 1990, f) The capital stock index; the base year is 1990, and g) Fixed density and Mobile density. The Exogenous Variables are a) Country economic indicators (The population of a nation, in millions , The share of urban population of a nation, GDP per capita of a nation, in 1995 U.S. $) CPI (CPI p 1 in 1990)) and Telecom reform variables (A dummy of full (or control) privatization, which is one for a nation in a year in which the majority owners are non-state, A dummy of partial (or revenue) privatization, which is one for a nation in a year when there was positive private ownership but state ownership still dominates, A dummy of privatization, which is one for a nation in a year when there was either

full or partial privatization, An index measuring the degree of competition in the telecom sector; it is zero when a national monopoly exists in the sector, one when there is competition (that is, more than one operators) in either the fixed or the cellular segment, and two when there is competition in both segments).

The study found that (i) Full privatization and competition have a significant positive effect on investment. (ii) Full privatization has an important positive effect on increasing fixed-line and mobile densities, while, competition only has a significant effect on mobile density. (iii) Full Privatization tends to increase the industry output but also prices. (iv) Privatization increases labor productivity by almost 50% and competition by almost 10%.

Waverman et al. (2006) attempted to determine the effects of public ownership and regulatory agency independence on regulatory outcomes in EU telecommunications. The authors estimate the cost of terminating a call on the incumbent network as a function of density, government ownership, regulatory independence and experience of the regulator. Pooled OLS is used to estimate the equation[117]. The dependent variables are per minute rate charged for call termination on incumbent fixed line networks, while the exogenous variables are population density, degree of urbanization, dummy Coded 1 if government shares ≥ 0.5; coded 0 otherwise, EURI-I Index of regulatory independence, total number of main telephone, number of years since liberalization of telecommunications industry.

The key findings are:

(i) Public ownership of the incumbent positively affect incumbent's interconnection rates.

(ii) The presence of institutional features enhancing regulatory independence from the government mitigates this effect. It should be noted that the data sets exhibit some problems: a) There are some variables that don't change every year such as the dependent variable and regulation index; b) The EURI-I measures independence in theory. For example, the UK scores only moderately on the EURI-I index, yet most industry experts regard the UK as the benchmark in independent telecommunications regulation in the EU.

Grzybowski (2008) studies the determinants of incumbent retail prices for fixed-line services across the EU. The author estimates a reduced-form model for incumbent prices in the fixed telecommunications industry. He uses a data panel analysis incorporating fixed and random effects using OLS and then he estimates the equation using instrumental variables (2SLS) to test for the exogeneity of interconnection charges and regulation. The Dependent Variable is price of fixed line service while the independent ones are dummy for liberalization of fixed telephony, dummy for implementation of number portability in fixed line, dummy for implementation of carrier pre-selection for national calls, dummy for presence of unbundled local loops, hourly labor compensation cost in industry in $US PPP, ten-year government bond yield, termination charges for a call of 5 min duration, and GDP per capita in $US PPP. The

[117] Seven specifications of the model are estimated, none of them are free of problems.

countries considered include Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and U.K.

The key finding is that liberalization of fixed-line telephony and regulation, such as, implementation of carrier pre-selection and number portability had a negative impact on residential prices. Regulation decreased average price levels across the EU in the years 1998-2002 by about 8.2%. The author finds serious problem dealing with co linearity of the regulation variables. While it seems implausible that prices of mobile services wouldn't have an effect of the price of fixed-line services, the author doesn't give an explanation of why he didn't consider them on the model.

Grajek et al. (2009) attempted to quantify the impact of access regulation on investment. The authors relied on a three equation system to analyze the effect of regulation on investment by incumbents and entrants. The first equation denotes the current level of regulation as a function of the stock of incumbents' and entrants' infrastructure and the intensity of regulation in the past[118]. The second equation models the incumbents' investment decision as a function of the intensity of regulation, the stock of the incumbents' infrastructure in t-1 and the sum of the stock of entrants' infrastructure. The third equation models the entrants' investment decision as a function of the intensity of regulation, the stock of the entrants' infrastructure in t-1 and stock of incumbents' infrastructure. Finally, the authors estimate the equations using OLS and instrumental variables (IV). The main variables comprise incumbent's infrastructure stock, entrant's infrastructure stock, regulation Index of access regulation intensity (higher values indicate higher intensity of regulation)[119]. The Control Variables comprise a dummy variable set equal to 1 if there are no entrants in the market, and zero otherwise, GDP per capita, average index of access regulation intensity in neighboring markets[120], government's attitude towards regulation, government's ideological position on the right-left scale, and government's attitude towards European integration[121]. The data used in our estimations cover more than 70 fixed-line telecoms operators in 20 EU member states during the period 1997-2006.

The principal findings are as follow:

(i) Access regulation discourages investment by incumbents and individual entrants even as entrants' total investment increases[122].

(ii) Endogeneity of regulation matters empirically[123].

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[118] This first equation takes into account the premise that regulators adjust their policies according the levels of investment in infrastructure, in other words is an endogenous variable.

[119] See Plaut Economics

[120] See Plaut Economics

[121] For information about the last three variables see Manifesto Project

[122] In terms of magnitude, we estimate the overall effect of access regulation on total industry investment in Europe to be a loss of some €16.8 billion over the past 10 years

[123] Specifically, absent controlling for endogenous regulation, there is not a significant impact of regulation on investment, but there is a significant effect when regulation is permitted to be endogenously determined by level of infrastructure investment.

(iii) Regulatory responses to infrastructure investments differ between incumbents and entrants, whereas access regulation is not affected by entrants' investment, regulators toughen access regulation in response to increased investment by incumbents.

From the literature revisited we have detected at least three difficulties: endogeneity, omitted variables and quality of information. At least two studies indicate the existence of endogeneity regarding competition, privatization and regulation: Wallsten (2001) and Grajek et al (2009). Both works note that reforms may affect telecom performance, but performance may also affect reforms. While, Wallsten (2001) only addresses the problem, Roller et al (2009) include reforms as an endogenous variable and finds that the correction caused in the model is significantly.

Li et al (2004) find important to include a variable of quality of service in the analysis. They find that privatization increases prices, but they can't explain this result because of the lack of a measure of QoS.

Waverman (2006) points out another problem regarding the data used in these types of analysis. The information about the regulator measures independence in theory not in practice. For instance, the EURI index that he uses as a proxy of independence ranks the UK regulator only moderately, yet most industry experts regard the UK as the benchmark in independent telecommunications regulation in the EU.

6. Conclusions:

From our review of the research literature, we can confidently conclude that all authors, with the exception of Wallsten (2001), have ascertained the importance of the policy and regulatory variable in driving telecommunications development, in addition to performance of the sector as a whole in terms of level of investment and productivity. Furthermore, the studies tend to validate the concepts of platform-based competition, privatization of the incumbent, and liberalization as the primary tenets of an environment that fosters development of the industry. Furthermore, the institutional framework does not appear to play as important of a role, especially in terms of wireless penetration.

The research review also allowed us to identify a number of common methodological issues affecting prior work that our study design needs to address, from endogeneity to non-linearity and co-linearity.

7. Appendix I: Scorecards:

7.1. Overall Institutional Environment:

The first section examines the effectiveness of the general institutional framework and environment in which the NRAs and market players operate.

Section A.1 examines the proper transposition of the EU regulatory framework

1) Proper transposition of the EU regulatory framework

Section A.2 examines the enforcement powers entrusted to the NRA

2) Power of the NRA to impose fines up to what level
3) Power of NRA to impose periodic penalty payments
4) Power of NRA to suspend commercial launch of services pending compliance
5) Power of NRA to impose functional separation

Section A.3 examines the NRA's scope and scale of resources.

6) Total number of qualified employees employed by the NRA for general regulatory issues in the e- communications sector
7) Financial capability of your NRA to attract and retain suitably qualified key staff
8) NRA responsibility for spectrum

Section A.4 examines the NRA's independence

9) Restrictions on the NRA's discretion for the market analysis and imposition of remedies
10) Power to give directions to the NRA
11) Governmental intervention required for adopting decisions
12) Grounds for removal of the head of your NRA.
13) Percentage of the incumbent's share capital held by the Government.

Section A.5 examines the NRA's power as a dispute settlement body for settling disputes

14) Competence of NRA for dispute settlement matters.
15) Power of the dispute settlement body to adopt interim measures.

Section A.6 examines the effectiveness of the appeals procedure.

16) Applicable standard to obtain suspension of the NRA's decision and application in practice (if applicable)
17) Average (median) timeframe between the filing of an appeal and the final decision (i.e., entire appeal process is exhausted)
18) Locus standi requirements for third parties to be allowed to challenge NRA decisions
19) Market analyses being appealed
20) Number of judgements annulling or overturning appealed decisions

7.2. Key Enablers for Market Entry and Network Roll-Out:

Section B.1 examines the regime pertaining to the rights of way, an important enabler to promote infrastructure competition

21) Is there a common nationwide procedure setting out rights and the application process governing rights of way for telecommunications?
22) Is there a common procedure for efficient resolution of disputes regarding rights of way before a single nation-wide dispute settlement body?

23) What are the charges levied (if any) for obtaining rights of way (on public land)?
24) What is the average timescale from formal application to obtaining permissions for rights of way?
25) Availability and effective use of ducts.

Section B.2 examines the effectiveness of the regime pertaining to numbering

26) Average timeframe for reservation of numbers.
27) Number portability for VoIP
28) Use of geographic numbers for VoIP services with a nomadic character.
29) Average wholesale price for porting fixed numbers.
30) Proportion of ported fixed numbers.
31) Timescale from fixed number porting application to actual switch.
32) Average wholesale price for porting mobile numbers.
33) Proportion of ported mobile numbers.
34) Timescale from mobile number porting application to actual switch.

Section B.3 examines the effectiveness of the regime pertaining to frequencies

35) Rules on spectrum trading envisaged or in place.
36) No service/technological restrictions on the use of 3.5 GHz frequencies.
37) No service/technological restrictions on the use of 2.6 GHz frequencies.
38) Plans to adopt technological neutral conditions for the 900/1800 MHz band.
39) Progress towards making digital switch-off.
40) Frequency allocation resulting from the digital switch-off.
41) Availability of spectrum for mobile TV.

7.3. NRA's Regulatory Processes:

Section C.1 examines the of regulators' processes for the analysis of markets and application of remedies.

42) Number of markets for which the NRA has adopted a final decision.
43) Number of markets for which the NRA has completed a second round market analyses (regardless of whether this was made on initial or revised recommendation).
44) Average (median) duration of a market analysis procedure by the NRA.

Section C.2 examines the transparency of the NRA's decision-making processes and the ability for all stakeholders to actively contribute to the decision-making

45) Timescale usually given to interested parties to respond to comment on proposals of general interest
46) Requirement for or common practice of the NRA to publish all its decisions upon adoption
47) Confidentiality of the data
48) Publication of action plan which sets out specific forward-looking targets and deliverables and allows consultation.
49) Transparent costs of operating the NRA.

Section C.3 examines the NRA's enforcement record.

50) How many breaches of imposed SMP obligations have been notified?

51) NRA's enforcement actions taken over the three last years (up until 31 August 2008) in relation to breaches of SMP obligations.

Section C.4 examines the efficiency of the NRA acting in its capacity of dispute settlement body.

52) Timeframe for obtaining a final decision from the dispute settlement body, over the past two years
53) Mandatory timeframe for negotiations (if any) before a dispute can be submitted to the dispute settlement body
54) Publication of disputes by the NRA
55) Consultation of third parties

7.4. Application of Regulation by the NRA:

Section D.1 assesses technological neutrality and forward looking approaches by examining if the regulatory environment and market conditions favour the principle of technological neutrality, including if the definition and remedies for leased line and access markets have been created on a technologically neutral basis. Also assessed in relation to forward-looking approaches are if IP interconnection has been considered in voice termination markets and if fixed incumbents have made reference offers available for duct access.

56) Definition of leased line market and remedies applied on a technologically neutral basis including Ethernet interfaces
57) Definition of wholesale broadband access market and any remedies applied on a technologically neutral basis
58) Definition of market for local access on a technologically neutral basis to include lines provided via fibre
59) NRAs remedies to facilitate downstream competition in local access markets.
60) Determination of the technical/operational and pricing conditions for IP interconnection in the terminating segment.
61) Establishment of conditions for closure of MDF sites or other interconnection points.

Section D.2 Operational Conditions.

62) Presence and effectiveness of SLAs dealing with LLUs, wholesale broadband access, and terminating segments of leased lines.
63) Presence and effectiveness of KPIs dealing with LLUs, wholesale broadband access, and terminating segments of leased lines.
64) Bulk migration process availability for wholesale broadband access to ULL, from Shared Access to Full ULL, from traditional interface and from wholesale or retail leased lines towards Ethernet.
65) Number portability synchronization with LLUs, wholesale naked bitstream, and WLR.

Section D.3 Pricing Conditions examines compliance monitoring (pricing issues).

66) Associated requirement typically introduced of accounting separation.
67) Methodology for accounting separation clearly specified and subject to consultation
68) Publication of separated accounts
69) Sufficient detail of NRAs published accounts available to third parties.

Section D.4 Non-price conditions examine compliance monitoring (non-price issues).

70) Elaboration of non-discrimination requirements.
71) Mechanisms in place which require use of same ordering by SMP and competitors.
72) Specific rules to restrict transfer of information

7.5. Regulatory and Market Outcomes:

Section 7.E.1 examines the competitive conditions prevailing for the provision of narrowband voice telephony services, and the effectiveness of regulation relevant to the competitive development of this market

73) Level of the incumbent's interconnection tariffs for call termination with interconnection at:
    - the local switch level;
    - the single tandem switch level;
    - the double tandem switch level
74) Existence of capacity-based interconnection offer for:
    - all calls;
    - internet-only
75) Proportion of customers using an alternative provider to the incumbent for direct access to telephone services on the basis of an alternative network
76) Proportion of customers using an alternative provider to the incumbent for direct access to telephone services on the basis of ULL
77) Proportion of customers using an alternative provider to the incumbent for direct access to telephone services on the basis of WLR
78) What proportion of lines are active CPS lines compared to the total number of incumbent lines?
79) Market share (revenue) of alternative operators in the fixed voice market
80) Proportion of telephone subscribers receiving services via VoB on stand-alone or bundled basis by incumbents or Altnets
81) Value of the retail price basket for residential customers
82) Value of the retail price basket for business customers

Section 7.E.2 examines the degree of competition and application of economic regulation in mobile markets

83) Rates for fixed to mobile termination charge applied by the largest (in revenue) mobile operator in your country
84) Market shares (by revenues) on the retail market of the 2 largest mobile operators
85) Price of the basket for low users of mobile retail services
86) Price of the basket for average users of mobile retail services
87) Operation of one or more "real" MVNOs
88) Operation of one or more SP
89) Market share of MVNOs and SP

Section 7.E.3 examines the effective regulation and degree of competition for the provision of services to business customers

90) Availability of partial private circuits.
91) Price of set-up and monthly rental for a 2Mbit/s, 5km PPC

92) Price of set-up and monthly rental for a 34Mbit/s, 5km PPC
93) Availability of WES on discriminatory terms
94) Price of a 2Mbits/s, 200km leased lines from the incumbent

Section 7.E.4 considers if the provision of wholesale broadband access is competitive.

95) Set-up and recurrent tariff charged for full ULL.
96) Set-up and recurrent tariff charged for shared ULL access.
97) Number of unbundled lines and shared access as a percentage of total (retail) DSL lines.
98) Unbundled fibre full loops or subloops (from the ODF) are available in the market
99) Use of sub-loop unbundling (SLU).
100) Percentage of broadband lines supplied end to end by competitors on the basis of cable, fibre, fixed wireless networks and own copper network
101) Percentage of DSL lines provided by competitors on the basis of wholesale bitstream access
102) Availability of wholesale naked bitstream access
103) What is the average price per megabit for retail broadband access offered on the market
104) Percent of (i) incumbent and (ii) new entrant DSL subscribers receive IPTV

8. Appendix II: Regulatory Density Index:

8.1. Structure:

Table 1. Sub-indices and indicators

Sub-indices	No.	Indicators
Price regulation	1	Which interconnection regime is applied to the incumbent's fixed-line network?
	2	What interconnection regime is applied to the incumbent's mobile communications network?
	3	What mobile termination regulation is applied?
	4	Amount of weighted average cost of capital accepted by the regulator a)
	5	Existence of sector-specific retail price-regulation for fixed network services?
	6	Existence of sector-specific retail price-regulation for mobile communications services?
Quantity regulation	7	Existence of a USO-burden for incumbents (USO=Universal Service Obligation)?
	8	Existence of a (financial or other) USO-burden for other telecommunications companies?
	9	Existence of meet-demand clauses for specific products or services at regulated prices?
	10	Are there regulatory requirements regarding coverage of the population with 3G mobile communications technology?
Market-entry regulation	11	Existence of regulated vertical separation of the incumbent company?
	12	Accounting separation requirement to ensure non-discrimination?
	13	Is full local-loop unbundling regulated?
	14	Is line sharing regulated?
	15	Is bit-stream access regulated?
	16	Is sub-loop unbundling regulated?
	17	Number of network-based mobile communications licenses of the 2nd generation?
	18	Number of network-based mobile communications licenses of the 3rd generation?
	19	Is frequency trading regulated?
Miscellaneous regulations relevant for investment incentives	20	State's shares of the incumbent in percent?
	21	Existence of a 'golden share' (right to veto, that can be applied by the government)?
	22	Is there an asymmetric access regulation between DSL and cable network providers?
	23	Is there a sector-specific environmental regulation (e.g., regarding radiation limits)?
	24	Can fines issued by the regulator exceed 5% of turnover of activity concerned?
	25	Are there any sector-specific regulations in connection with rights of way?

Table 2 Selection criteria and valuation of the indicators

Indicators 1, 2, and 3	**Interconnection regulation**		**Valuation**
	Regulation of the network monopoly		1
	Incremental cost accounting		1
	General cost regulation		0.8
	Combination of all regulations		0.8
	Price-cap regulation		0.5
	Rate-of-return regulation		0.5
	No regulation (competition law)		0
Indicator 4	**WACC (before tax, if available real, otherwise nominal)**		**Valuation**
	Lower threshold (>=)	Upper threshold (<)	
	0	7%	1
	7%	10%	0.8
	10%	14%	0.5
	14%		0
Indicators 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 19, 21, 22, 23, 24, and 25	**Yes or no**		**Valuation**
	Yes		1
	No		0
Indicators 17 and 18	**No. of licenses**		**Valuation**
	1 2 3 4 More than 4		1 0.8 0.5 0.5 0
Indicator 20	**State's shares**		**Valuation**
	Lower threshold (>=)	Upper threshold (<)	
		80%	1
	51%	80%	0.8
	20%	51%	0.5
		20%	0

8.2. Data Sources:

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So far 12 implementation reports have been released; the 5th to the 12th edition were downloadable in August 2007 at http://europa.eu.int/ISPO/infosoc/telecompolicy.

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- Baker & McKenzie (2005), Telecommunications Laws in Europe, 5th edition, published by Joachim Scherer, Tottel Publishing, West Sussex.

- Websites of the national regulatory authorities where the relevant decrees from the 27 member states of the European Union can be consulted.

9. Appendix III: Policy Index Methodology:

The author defines five sub-categories that will form the policy index:

1) **MA/Trade:** designed to capture policies that discriminate against all potential entrants seeking to supply cross-border telecommunications services. It is constructed from the ITU data on individual country policies towards leased lines and resale. There are six observations for each country. A score of 1 is given for each instance where no restrictions were apparent, a score of 0 for any reported restriction or empty cell. Hence an index is created with scores ranging from 0-6.
2) **MA/invest (fixed):** This is an index designed to capture policies that discriminate against all potential entrants seeking to supply fixed network services via investment in the country at issue. The index is a weighted average of scores from three questions:

Does competition operate in the market for fixed services?

- A score of 1 for a Monopoly
- A score of 2 if there are only two companies
- A score of 3 if there are three or more companies
- The scores (1-3) are then multiplied by the weight (3).

Source: ITU information on ownership

Does policy allow for competition in the market for fixed services?

- Five sectors are considered from the core of fixed network services: local, domestic long distance, international, data and leased lines.
- A score of 1 is provided if the ITU found that full competition is allowed, with 0.5 for partial competition and 0 for a monopoly situation
- The scores (0-5) are then multiplied by the weight (2)

Is the incumbent privatized?

The fraction of the incumbent that is privatized (0.0-1.0) is multiplied by the weight (1)

3) **MA/invest (mobile):** This is an index designed to capture policies that discriminate against all potential entrants seeking to supply cellular mobile services via investment in the country at issue. The index is calculated in much the same way as MA/Invest (fixed).
4) **NT/trade:** This is an index designed to capture policies that discriminate against potential foreign entrants seeking to supply cross-border telecommunication services. It is constructed from the ITU data on individual country policies relating to callback services. It is a dummy variable that takes a value of 1 if callback is allowed and 0 if it is not.
5) **NT/Invest:** is designed to capture policies that discriminate against potential foreign entrants seeking to supply fixed or mobile telecommunication services via investment in the country at issue. The variable represents the percentage of foreign investment allowed in competitive carriers.

Note: The weights given to each of these scores reflect a subjective assessment of their relative importance in terms of producing competitive outcomes in the market for telecommunications services.

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