COMMITMENT AND REGULATORY INDEPENDENCE IN PRACTICE IN LATIN AMERICAN AND CARIBBEAN COUNTRIES

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Abstract
We present an analysis of the evolution of regulatory independence in practice for 23 Latin American and Caribbean countries in the telecommunications industry. Based on this analysis, we construct realistic indices of regulatory independence, which improve upon the measures of independence that have been used so far in the empirical regulation literature. We show that legal indices may give a partially distorted picture of the commitment ability of institutions. The combination of *de facto* and *de jure* independence has a positive (probably modest) impact on network penetration in telecommunications markets, although treating independence as exogenous may underestimate its impact.

Key Words: regulation, independence, strategic delegation, telecommunications.
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1. Introduction

Institutions matter in any field of economic policy. For example, the econometric treatment of the effects of good institutions on macroeconomic performance is a very active field of research, and is increasingly inspiring empirical research in microeconomic policies. Credible commitments are seen as one of the few recommendations that survive after many studies, although the recommendation leaves broad space to fill in the details. Levy and Spiller (1996) stress this point for the case of the regulation of privatized utilities.

The analysis of the independence of regulatory agencies is part of this increasing interest in the institutions of economic policy. Independence is seen in the economics literature as a way to strategically delegate into an agent (the regulator) who is more reluctant than a representative government to expropriate specific investments. Mishkin (2006) argues however that "although dealing with time-inconsistency problems by appointing a conservative policymaker has attractive theoretical properties, it is not so easy to implement in practice." Mishkin points out difficulties with this approach to solving the time-inconsistency problem, using the example of monetary policy. It may

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be hard to find a central banker with the "right" preferences and it is hard to believe that politicians would naturaly want to appoint central bankers with different preferences than theirs, so that a regime based on having a conservative central banker is unlikely to be stable over time. Similar objections apply to appointment of a conservative regulator/supervisor.

An independent regulatory agency is also seen as a way to attract professional experts[2] and to stabilize policies in the presence of political volatility (see Evans et al., 2007). The idea of strategically delegating into "independent" agents has gained predicament in the recent decades, but it is not new. Troesken's (1996) study of the transition between local and state regulation in the US reports that local regulations were decided mostly directly by the City Council. However, occasionally, experts were called, but (interestingly for our purposes) their advice was not always heeded: in the fall of 1910, months before the 1911 mayoral election in Chicago, the city hired W.J. Hagenah to head an investigation into the costs of manufacturing and distributing coal gas. Hagenah, chief accountant of Wisconsin's utilities commission, spent six months investigating the company's plants and books. Several engineers and accountants associated with the Wisconsin (the neighbouring state) utilities commission helped in the investigation. Hagenah presented his report to the city council in mid-April, shortly after the election. He recommended that the price of gas be set at 77 cents -per MCF or one thousand cubic feet-. Since many of the elected councillors had endorsed during the electoral campaigned the proposals of the "70 Cent Gas League," the city council tabled Hagenah's report, introducing an ordinance reducing gas rates to 70 cents, and began searching for a new expert.

The problem of course is that independence does not solve, but it relocates, the commitment problem, which transforms itself into one of the government credibly committing not to undermine the independence of the regulator, which many jurisdictions have found very difficult. In a definition of Central Bank independence, Walsh (2005, 10) states that "legal measures of Central Bank independence may not reflect the relationship between the Central Bank and the government that actually exists in practice." Hence, the importance of developing continuous indices of independence in practice.

[2] Bernstein (1955, p.4): "In general, the Commission form has been championed by those who believe that administrative regulation requires a high degree of expertness, a mastery of technical detail, and continuity and stability of policy. These requirements, it is alleged, can only be met by a board of commissioners functioning in a neutral environment, free from partisan political considerations."

Work on the measurement of Telecommunications Regulatory Agencies (TRA) independence has mostly analyzed legal or *de jure* independence but not independence in practice or *de facto* independence. Most, but not all, of the work on legal independence has used dichotomous dummy variables, and these, as Estache et al. (2006, 12) point out, "may not capture the degree of independence". Others use indices reporting about the legal framework: whether there is primary legislation requiring an independent regulator, how is it funded, to whom should he or she report, etc.[3]. By independence in practice or *de facto* independence we mean what actually happens in the real relationship of regulatory agencies with the rest of government, and which could be measured (at least in part).

Even if it was possible to measure independence accurately, it is not axiomatic however that regulator independence should have a positive effect on industry performance. One of the weaknesses of independent agencies mentioned by Bernstein (1955) is lack of coordination with the general government (p.101: "the limited jurisdiction of most commissions narrows the administrative vision of the public interest"). Bernstein argues that one of the problems of insulation from the political process is precisely that lack of political skills may reduce the public support for the role of the regulatory agency. For example (p.101): "Independence is a device to escape popular politics. It facilitates maximum responsiveness by a commission to the demands and interests of regulated groups. It provides maximum freedom from exposure to popular political forces. It tends to alienate commissions from sources of political strength, especially the president, upon whom regulatory progress may largely depend. Independence acquires a sacred inviolability because it reduces the effectiveness of regulation and seems to satisfy the Congressional desire to lessen the power and authority of the president." We nevertheless show below that independence had a positive impact on telecommunications performance in Latin America and the Caribbean in the recent past, although this impact is probably modest.

We measure below independence in practice (for telecommunications[4] regulators in Latin America and the Caribbean), by undertaking case studies which

[3] Stern and Cubbin (2003), Pargal (2003), Edwards and Wavermann (2006), Gual and Trillas (2004 and 2006) and Montoya and Trillas (2007) are representative of this line of research and acknowledge the need for indices of independence in practice. See also Gutierrez (2003a), Ros (1999 and 2003), Viani (2006), Wallsten (2003), Ai et al. (2004) and Fink et al. (2002).

[4] Compared with electricity or water, the telecommunications sector is less prone to regulatory opportunism, given that assets are not as long lived. Then if we find that regulatory opportunism is an issue in telecommunications, we would predict that a similar and more serious phenomenon arises in

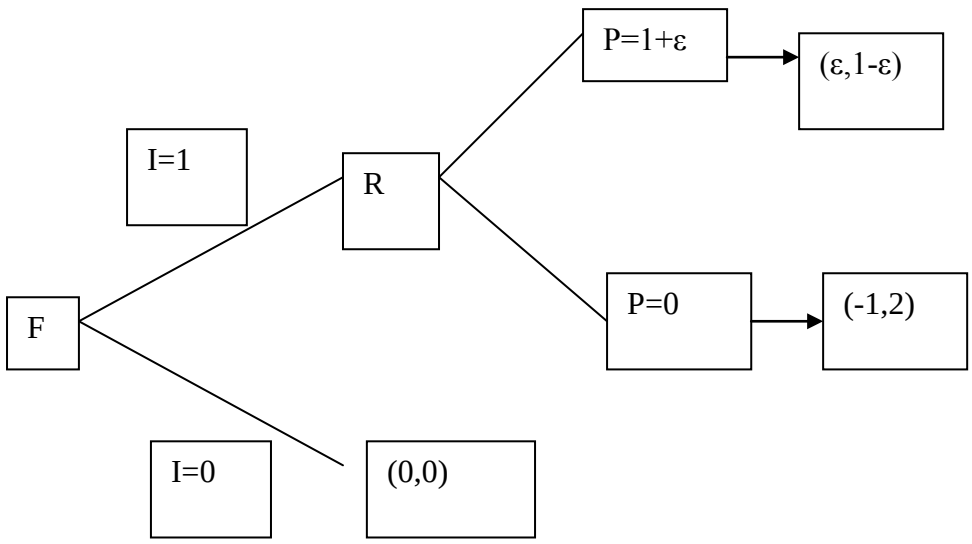
show telecommunications regulators' turnover ratio and allow us to quantify their vulnerability. We use these studies to analyze the impact of independence. The empirical methodology draws from the literature on Central Bank Independence. In the rest of this paper, in Section 2 we present some background on the independence debate. In Section 3 we present the case studies on 23 countries and build on these to construct indices of independence in practice. In Section 4 we put our measures to work, analyzing the determinants of penetration in fixed telephony, including an analysis of potential endogeneity problems. And finally we conclude in Section 5.

2. Theoretical Framework and Related Literature

In infrastructure industries, the importance of institutions is mainly driven by the sunk nature of the investments needed, which is the source of a time inconsistency problem, highlighted by Levy and Spiller (1996), Shirley et al. (2000), Noll (2000), Noll and Shirley (2002), Gutiérrez (2003a), Levine et al. (2005) and Newbery (2000), among others. Many countries face major difficulties in inducing sufficient investment to meet demand at an acceptable cost. The reason is that given the long-lived nature of sunk assets, unless firms have expectations that prices will be sufficiently high over time, they will be reluctant to invest. But at a given moment in time, if investments have already been sunk, policy makers under pressure from consumers will be tempted to fix low prices. Hence, the role of the regulatory institutions is crucial in providing the credibility that will support the necessary investment flows.

The following picture of an extensive form game summarizes with the simplest of models the time inconsistency problem in regulation that gives rise to the "independence" solution:

these other sectors. Underinvestment in the face of regulatory time inconsistency problems, however, has resurfaced in telecommunications as countries debate how to create a framework to promote next generation fiber networks, in spite of the increasing role played by competition and technological change.



In the game described in the picture, first a firm makes a decision on whether to undertake a specific investment (for example, a fibre optic network) or not, and next the regulator, if the firm has invested, decides whether to fix a price that remunerates the investment, or to expropriate this investment (zero price). The payoff of the firm is P-I, whereas the payoff of the (consumer welfare maximizing) regulator is 2I-P.[5] By backwards induction, if the firm has invested (I=1), the regulator will rationally fix P=0, and, anticipating this, the firm will not invest (I=0). Hence, in a sub-game perfect equilibrium, there is no investment. More realistic settings would include many other real world details, but if there is no commitment and assets are sunk, under-investment would remain a serious concern, perhaps in the form of bad maintenance or use of inefficient technologies.

The expropriation of the quasi-rents derived from specific investment may not necessarily take the form of too low prices, but it can take other forms, such as unexpected investment requirements, costly unanticipated quality improvements, or requirements to hire inefficient staff. Policy makers may follow this path and still benefit from the (already in place) investments. Ex ante, however, investors will anticipate this, and investment levels will be sub-optimal. The opportunity cost of reneging will depend on country characteristics, such as the institutional endowment, the degree of income inequality, or the nature of fiscal systems. In countries with

[5] Any objective function of the regulator equal to γI-P with γ>1 would yield the same results. We use γ=2 for concreteness.

skewed income distributions, governments pay a political price in terms of not satisfying the median (relatively poor) voter if they do not renege on promises made to remunerate specific investments. The problem may be alleviated by long term contracts, repeated interactions, reputational mechanisms or institutions that make credible that the P=0 path will not be taken. Historically, public ownership (the state internalizing the firm's problem) has been a way to alleviate time inconsistency, but in the recent decades policy makers in many countries recognized that the costs of public ownership in terms of public funds and inefficient practices outweighed its benefits. Thus, the solution of privatizing and strategically delegating into an independent regulator who cares to a certain extent about the firm's rents, in a similar way that governments delegate into an inflation-averse central banker (see Levine et al., 2005). The need for experts in technologically complex sectors and the wish to give certainty in politically volatile regions reinforce the argument of independence.

However, it is not axiomatic that independence will automatically yield good investment results, as there are other mechanisms to achieve commitment, to attract experts, and to avoid political volatility. For example, it is widely recognized that Chile has achieved a high degree of commitment in privatizing utilities through a very detailed and difficult to change legislation. It is an empirical question whether Chile is an exception that can be explained by its unique history and a very specific political and institutional system that makes policy reversal very difficult, or whether it is an example that can be generalized.

One problem of course is that independence does not solve, but it relocates, the commitment problem, which transforms itself into one of the government credibly committing not to undermine the independence of the regulator, which many countries have found very difficult, as we show below in Section 3. Then a potential measure of independence in practice is for how long do politicians respect the period in office of appointed regulators. And this is the research strategy we follow below.

An independent (or at least separate from government) regulator is generally associated with attempts to reform regulation. Wallsten (2001, 8) argues that having a separate regulator is a sign of how willing a country is to reform regulation. There are at least ten studies about telecommunications regulation which measure legal (*de jure*) independence of the regulatory agency; five of them use dichotomous variables and the others use indices, but none of them measures independence in practice. In most (but

not all) cases the measures that have been used so far have a positive impact on some performance measures (typically, network penetration, see Table 1).

Table 1. Studies on Telecommunications Regulation and Telecommunications Regulatory Authorities (TRAs)

Study	*Type*	*Characteistics*	*Data Sources*	*Result*
Bortolotti et al. (2002)	*D*	Date in which the agency starts operating	ITU	The creation of TRA is non-significant in most estimations
Edwards and Waverman (2005)	*I*	Twelve-component index	EC and other	TRA' independence is significant by itself and interacting with privatization
Fink et al. (2002)	*D*	Whether country has a separate regulatory agency or otherwise	ITU	Significant in most estimations
Gual and Trillas (2004)	*I*	Nine-component index	ITU, OECD, and others	Legal TRA is non-significant.
Gutiérrez (2003a)	*I*	Four-dimension index of regulatory governance	Own research	Positive and significant (at 1% level) in tele-density and efficiency (at 10% level)
Henisz et al. (2005)	*I*	Four dimension index	ITU	Deregulation is robust and significant
Pargal (2003)	*I*	Six-dimension index	Guasch (2001)	TRA independence gives mixed results depending on the dimension
Ros (2003)	*D*	Whether there is a separate agency	ITU	Positive and significant at 10% level for expansion and at 1% level for efficiency.
Wallsten (2001)	*D*	Whether the country's agency is Ander the control of a Ministry.	ITU	Non-significante at 1% and not always at 5%

Wallsten (2003)	*D*	Whether the agency was established before privatization.	ITU	Positive and significant in three different regressions.
	D	Whether the Regulatory agency states that it is independent relative to politicians.	ITU	Negative and significant at 5%

D: Dummy; *I*: Índex

Although in theory other mechanisms could alleviate the time inconsistency problem faced by regulators, the literature points out that it is difficult[6], at least for developing countries, to find credible (and consistent over time) alternatives to an independent regulatory agency.

An important issue is then what do we mean exactly by independence. Edwards and Waverman (2005, 25) argue that independence is more than a group of formal institutional rules; it also has important informal aspects which usually depend on centuries of legal and political traditions, cultural norms and individuals.

We therefore think that more emphasis should be put on *de facto* regulatory independence. Edwards and Waverman (2005) suggest that there seems to be a negative correlation between formal (*de jure*) regulatory independence and independence in practice (*de facto*), because in those countries with weak informal mechanisms to ensure regulatory independence, these are compensated with strong formal arrangements in order to persuade potential investors that there is no regulatory bias.[7]

The drawback of legal indices or dichotomous variables which measure regulatory independence is that they only reflect the state of legislation, and events and politicians may leave the law aside.[8] An implication of this is that inferences derived from such data sets for telecommunications, electricity and other industries can potentially give distorted pictures about the real effect of regulatory governance, as Stern and Cubbin (2003, 22) point out.

Thus there is the need to enlarge the data bases to develop empirical work which tests the effects of a well functioning regulatory regime using data about the process or practice of regulation, for example, as stated by Levine, et al. (2005, 469), by

[6] See Gutierrez (2003a) and Levine et al. (2005)

[7] However, they do not measure empirically the practice of independence in their work.

[8] An illustrative example of the problems of appointment, continuity and independence of commissioners in a regulatory agency is the regulation of electricity in India, where laws establish that commissioners' appointments must be for 5 years with a compulsory retirement age of 62. Most commissioners are appointed around 60 years old, so that they can only stay in their jobs for 2 or 3 years, according to Stern and Cubbin (2003, 18).

measuring "the percentage of commissioners or directors of regulatory agencies who end their term prematurely." The empirical evidence on the effectiveness of Central Bank Independence support this notion. Pargal (2003) also points out, when explaining the limitations of his research, that lack of data made impossible to assess the importance of aspects of independence such as security and duration of the contract of the regulator.[9]

The measurement of independence in practice for Central Banks is quite developed in the literature.[10] According to Eijffinger and De Haan (1996) a Central Bank is independent if its monetary policy is not influenced by political cycles or by the preferences of politicians. As an example of the empirical literature on Central Bank independence, Cukierman (1992) creates a 16-variable legal index for 68 countries, reporting data on (i) hiring and firing rules for the Chairman; (ii) policy formulation; (iii) final objectives, and (iv) borrowing limitations.

As a *proxy* for independence in practice he uses the average time (or turnover ratio) in the position of Central Bank governor or chairman. Cukierman (1992, 383) clarifies that there is no obvious measure of actual (in practice) independence as opposed to legal Central Bank independence. He points out that this is not because it is not important, but "because it is difficult to find a group of systematic measures of actual independence when this diverges from legal independence". He finds that the measure of legal independence and the turnover rate of the Central Bank governor differ by a larger amount in developing rather than in developed countries.

Cukierman and Webb (1995) calculate yet another variable of independence in practice which they call (political) vulnerability index. This reflects the political influence in the central bank by measuring the probability that the Central Bank governor will be replaced immediately after a political change in government. They use a sample of 67 countries for the 1950 to 1989 period. They find that in a six months period the governor changes in half of the cases after a non-radical (i.e., not related to a military rebellion, restoration of democracy or constitutional change) political change. They find that it is much less likely that the governor changes after six months of a routine transition in the Executive. There exists high variation among countries, and a large difference between developing (change in one quarter of cases) and developed

[9] See also Wallsten (2003) or Estache et al. (2006).
[10] See Eijffinger and De Haan (1996), De Haan and Kooi (2000) and Arnone, Laurens and Segalotto (2006).

countries (change in one tenth of cases). They also find that their measure is correlated with the level and variance of inflation, with real growth and with real interest rates.

The authors show that the frequency of governor changes is higher the closer the date of the political transition. They stress that the political turnover measure by itself is an imperfect measure of independence in practice. A *low* ratio does not necessarily mean high independence (in some cases such as Denmark, United Kingdom or Iceland it is; but not in others such as countries with stable authoritarian regimes). Instead, they argue that a *high* ratio does reflect low Central Bank independence, because high turnover ratios mean that the governor's period is shorter than the executive's and this makes the governor more vulnerable to the influence of the President or the political majorities. And hence will be less prone to try to implement long run policies.

De Haan and Kooi (2000) analyze Central Bank independence in practice for 82 developing countries. They conclude that (lack of) independence is only correlated with inflation if we take into account countries with large price increases. They report that independence works better in developed rather than in developing countries.[11] Table 1 summarizes the evidence.

Table 2. Studies measuring Central Bank independence in practice in developing countries.

Article	*Number of countries (developing)*	*Estimation Period*	*¿Does it use a legal index?*	*Variable measuring independence in practice*
Cuikermann (1992)	68 (49)	1950-1989	YES	Turnover Rate
Cuikermann et al. (1992)	71 (50)	1950-1989	YES	Turnover Rate
Cuikermann and Webb (1995)	67 (47)	1950-1989	YES	Vulnerability
Akhand (1998)	62 (40)	1960-1989	YES	Turnover Rate and Vulnerability

[11] See also Akhand (1998).

De Haan and Kooi (2000)	82 (82)	1980-1989	NO	Turnover Rate

3. The Construction of Measures of Independent Regulation in Practice

In this Section, we first explain the data collection process about the beginning and end of the period in office of the head of TRA (Telecommunications Regulatory Authority). Next we explain the construction of a vulnerability index which uses the changes in the head of the agency as a measure of independence in practice. Next we explain the construction of an index of independence in practice that reports about and weighs for the reason why the head of agency leaves his or her position. From the combination of these two indices of independence in practice with an index of legal independence we create two indices that combine legal issues and the practice of regulation for 23 Latin American and Caribbean countries.

Data collection

To create a vulnerability index and a practical independence index in Latin American TRA's it is key to have information about the exact date of beginning and end of the period in office of the head of the agency, as well as the reason for which the head of the agency leaves his or her position (end of term in office, dismissal or other).[12]

We obtained complete data on the beginning and end of the director or chair person of the agency for 23 countries in the Latin America and Caribbean region for the period between 1990 and 2004.[13] .

Therefore, to obtain the necessary data we resorted mainly to three groups of sources:

[12] We think of the head of the agency as the most important member of the institution. We are aware of examples, such as Colombia, where government of the agency is in the hands of a council where each member has the same weight and the presidency rotates among the members (16 months each).

[13] For Haiti and Guyana it was impossible to obtain complete data for the period. We also exclude Cuba and Puerto Rico for their specific political or market characteristics.

i) The TRA's themselves. In some cases, in their web pages there are press bulletins, decrees, contracts, speeches or notes about the beginning and/or end of the time in office of the head.[14]

ii) Data bases of news about the region, such as *ISI Emerging Markets*, *ProQuest* and *Lexis-Nexis*. We also used the press of every country as well as contact with some analysts or local telecommunications research centres.[15]

iii) Bulletins and web pages of the above mentioned organizations AHCIET, ITU and REGULATEL. [16]

[14] For an analysis comparing the web sites of TRA in Latin America and the Caribbean, see Mahan (2005).

[15] In the case of Mexico, for example, we contacted the *Instituto del Derecho de las Telecomunicaciones* (IDET), the *Programa de Investigación de las Telecomunicaciones* from *Centro de Investigación y Docencia Económica* (CIDE) and a specialised editorialist in newspaper *Reforma*.

[16] Their web pages are: http://www.ahciet.net (AHCIET), http://www.itu.int (ITU), http://www.regulatel.org (REGULATEL).

Table 3.Telecom regulation agency and their presidents. 1990-2004

Country	Name of de Agency	Year of creation	President/Director Name	Start	End	Months
Argentina	Comisión Nacional De Telecomunicaciones	1990	Ceferino Namuncura	Jun-04	---	---
			Falvio M. Madaro	Jun-03	Jun-04	13
			Adolfo Luis Italiano	Mar-02	Jun-03	15
			Carlos Forno	Dec-99	Mar-02	27
			Roberto Catalan	Feb-97	Dec-99	35
			Alberto Gabrielli	Mar-96	Feb-97	11
			Raúl Agüero	May-95	Mar-96	10
			Oscar Gonzalez	Jun-94	May-95	11
			Rinaldo Colomé	Oct-93	Jun-94	8
			José L. Palazzo	Nov-91	Oct-93	23
			Raúl Otero	Jan-90	Nov-91[a]	22
Barbados	Fair Trading Commission	2001[b]	Neville Nicholls	Dec-03	---	---
			Frank King	Jan-01	Dec-03	35
Belice	Public Utilities Commission	1999	Gilbert Canton	Jan-99	---	---
Bolivia	Superintendencia de Telecomunicaciones	1995	René Bustillo P.	Jan-03	---	---
			Guido Loayza M.	Dec-97	Jan-03	61
			Carlos Saravia D.	Nov-95	Dec-97	25
Brazil	Agência Nacional de Telecomunicações	1997	Pedro J. Ziller de A.	Jan-04	---	---
			Luiz G. Schymura de O.	May-02	Jan-04	20
			Antônio C. Valente da S.	Mar-02	May-02	1
			Renato Navarro G.	Nov-97	Mar-02	53
Chile	Subsecretaria de Telecomunicaciones	1977	Chistian Nicolai O.	Mar-00	---	---
			Juanita Gana	Aug-97	Mar-00	31
			Gregorio San Martín	Mar-94	Aug-97	41
			Roberto Pliscoff	Mar-90[c]	Mar-94[d]	48
Colombia	Comisión de Regulación de las Telecomunicaciones	1994	Gabriel A. Jurado	Sep-04	---	---
			Mauricio López C.	May-03	Aug-04	16
			Carlos E. Balen y V.	Sep-01	Apr-03	20
			Néstor Roa B.	Aug-00	Aug-01	13
			Diego Molano V.	Sep-98	Jul-00	23
			Gustavo Peña Q.	Dec-97	Aug-98	8
			Douglas Velásquez J.	Nov-96	Dec-97	13
			Hilda M. Pardo H.	Feb-96	Oct-96	8
			Daniel E. Medina V.	Oct-94	Feb-96	16
			María J. París	Jan-94	Oct-94	9
Costa Rica	Autoridad Reguladora de los Servicios Públicos	1996	Aracelly Pacheco S.	Sep-03	---	---
			Hermann Hess A.	May-02	Aug-03	16
			Leonel Fonseca C.	Jun-98	May-02	46
			Rafael Carrillo L.	Aug-97	May-98	9
			Leonel Fonseca C.	Oct-96	Aug-97	10
Dominican R.	Instituto Dominicano de las Telecomunicaciones	1998	José R. Vargas	Aug-04		
			Orlando J. Mera	Aug-00	Aug-04	48
			Mariano G. Mejía	Jul-00	Aug-00	1
			José G. Sued	Apr-99[e]	Jul-00	16
Ecuador	Consejo Nacional de Telecomunicaciones	1995	Freddy Rodríguez F.	Jan-03	---	---
			José Pileggi V.	Feb-00	Jan-03	35
			Juan Hidalgo G.	Feb-99	Jan-00	10
			Mario Burbano De L.	Mar-97	Aug-98	17
			Carlos Manzur P.	Aug-96	Feb-97	6

			Esteban Pólit M.	Jan-96[f]	Aug-96	8
El Salvador	Superintendencia General de Electricidad y Telecomunicaciones	1996	Jorge I. Nieto M.	Jun-04	---	---
			José L. Trigueros.	Sep-01	May-04	33
			Ernesto Lima M.	Jul-99	Aug-01	25
			Erick Casamiquela	Dec-97	Jul-99	17
			Orlando de Sola	Sep-96	Aug-97	15
Guatemala	Superintendencia de Telecomunicaciones	1996	Oscar Chinchilla G.	Jan-04	---	---
			José Orellana M.	Jan-00	Jan-04[g]	48
			José Toledo O.	Feb-99	Jan-00[h]	11
			Mario Roberto P.	Sep-98	Feb-99[i]	6
			José Toledo O.	Nov-96	Sep-98[j]	22
Honduras	Comisión Nacional de Telecomunicaciones	1995	David A. Matamoros B.	Jan-04[k]	---	---
			Marlon Ramssés T.	Nov-02	Dec-03	13
			Norman Roy H.	Mar-98	Oct-02	55
			Adolfo L. Sevilla G.	Mar-98	Mar-98	0
			Francisco J. Valenzuela	Jul-96	Dec-97	17
			José G. Aquino	Oct-95	Jun-96	8
Jamaica	Office of Utilities Regulation	1995	J. Paul Morgan	Feb-03	---	---
			Winston Hay	Apr-95	Jan-03[l]	94
Mexico	Comisión Federal de Telecomunicaciones	1996	Jorge Arredondo M.	Nov-01	---	---
			Jorge Nicolin F.	Jun-99	Nov-01	29
			Javier Lozano	Apr-98	May-99	13
			Carlos Casassus	Aug-96	Apr-98	21
Nicaragua	Instituto Nicaragüense de Telecomunicaciones y Correos	1995	Joel Gutiérrez	Jun-04	---	---
			Eduardo Urcuyo L.	Dec-03	Jun-04	6
			Fausto Carcabelos	Aug-03	Dec-03	3
			Mario Gonzalez L.	Jan-02	Aug-03	19
			David Robleto	Feb-01	Jan-02	11
			Mario Gonzalez L.	Sep-99	Feb-01	28
			Mario Montenegro	Jan-97	Sep-99	49
			Rolando Rivas H.	Aug-95	Jan-97[m]	49
Panama	Ente Regulador de Servicios Públicos	1996	José Galán P.	Oct-04	---	---
			José D. Palermo	Dec-03	Oct-04	10
			Alex A. Arroyo M.	Feb-00	Dec-03	46
			José Guanti G.	Aug-96[n]	Feb-00	43
Paraguay	Comisión Nacional de Telecomunicaciones	1995	Luis A. Reinoso Z.	Jul-04	---	---
			Omar J. Ramos L.	Aug-03	Jul-04	11
			Osvaldo Bergonzi	Jan-03	Aug-03	7
			Victor A. Bogado G.	Jan-00	Jan-03	36
			Juan M. Cano F.	Jul-96[o]	Dec-99	42
Peru	Organismo Supervisor de Inversión Privada en Telecomunicaciones	1994	Edwin San Román Z.	Feb-02	---	---
			Jorge Kunigami K.	Jan-94[p]	Jan-02	95
Suriname	Telecommunicatie Autoriteit Suriname	1998	H.Guno Cautelen	Aug-00	---	---
			Dick De Bie	Jan-98[q]	Aug-00	31
Trinidad & Tobago	Telecommunications Authority of Trinidad and Tobago	2002[r]	Ralph Henry	Aug-04	---	---
			David Soverall	Jan-02	Jul-04	30
Uruguay	Unidad Reguladora de Servicios de Comunicaciones	2001	Fernando Pérez Tabó	Feb-01	---	---
Venezuela	Consejo Nacional de las Telecomunicaciones	1991	Alvin R. Lezama P.	Jul-03	---	---
			Jesse Chacon	May-01	Jul-03	26
			Diosdado Cabello	Feb-99	May-01	27
			José M. Padron I.	Jul-98	Feb-99	6
			José L. Avilez N.	Aug-96	Jul-98	24
			José Soriano	Oct-91	Aug-96	58
			Juan Mijares	Sep-91	Oct-91	1

Source: TRA's web pages, press bulletins, decrees, contracts and notes; ISI Emerging Markets, ProQuest, Lexis-Nexis, local press; bulletins and web pages of AHCIET, ITU and REGULATEL.

Notes:

a. We did not find the exact dates of the departure of Raul Otero and the arrival of José L. Palazzo, so we approximated the dates following notes on activities of both in newspaper "El Cronista" from Buenos Aires.

b. From 1978 to 2000 Public Utilities Board was operating. FTC was established as a statutory corporation on January 2nd, 2001 by the Fair Trading Commission Act 2001-31.

c. It has been followed since 1990.

d. We did not find the exact dates of the departure of Roberto Pliscoff and the arrival of Gregorio San Martin, but since the deputy secretary is appointed by the new country's president we assume that turnover coincides with the replacement of Aylwin by Frei (March 1994). This coincides with notes on activities of both regulator according to newspaper El Mercurio from Santiago.

e. Although the Regulatory body is created on May 27th, the board was appointed by presidential decree on April 1999.

f. Although it is created on August 30th 1995, the first president of CONATEL starts his tenure on this date.

g. We did not find the exact dates, so we approximated according to the fact that the Superintendent is appointed by the new Ministry of Communications and Infrastructure. We assumed that the turnover coincided with the change from Portillo to Berger in the country (January 1994). We also revised the public signed documents in the web page of SIT; the last document signed by José Orellana is on December 2003 and the first signed by Oscar Chinchilla is on May 2004.

h. We did not find the exact dates, and assumed that the turnover coincided with the change from Arzú to Portillo in the country (January 2000). We also revised the signed documents published in the web page of SIT. The last document signed by José Toledo is from December 1999 and the first signed by José Orellana is from April 2000.

i. We did not find the exact dates, so we approximated following signed documents published in the web page of SIT. The last document signed by Mario Paz is from January 1999 and the first signed by José Toledo is from April 1999.

j. We did not find the exact dates, so we approximated based on signed documents published in the web page of SIT. The last document signed by José Toledo is from August 1998 and the first one signed by Mario Paz is from October 1998.

k. We did not find the exact dates, so we approximated following signed resolutions published in the web page of CONATEL. The first resolution signed by David Matamoros is from January 2004.

l. We did not find the exact dates, so we approximated following speeches available on the web page of OUR. The last speech by Winston Hay was on January 2003 and the first speech by Paul Morgan was on March 2003.

m. We did not find the exact dates of the departure of Rolando Rivas and the arrival of Mario Montenegro. We approximated following notes on the activities of both in newspaper "El Nuevo Diario" and a note on *Nicaragua Country Commercial Guide 1996* from the *U.S. Department of State*.

n. It is created on January 29th 1996 but it starts functioning in August.

o. The law creating it is from May 25th 1995 but it starts functioning on July 1996.

p. There are laws from 1991 and 1993. But it starts functioning on 1994.

q. Since 1980 the Ministry of Transportation, Communications and Tourism was responsible for Telecommunications.

r. Trinidad and Tobago's Telecommunications Authority (TTTEL) was created in 2002. Following the promulgation of the Telecommunications (Amendment) Act 2004, the TATT was established replacing TTTEL.

Of the 17 countries in the region which have a period which is established by law, only in four of them the regulator completed the full period: Belize, Jamaica, Uruguay and Peru (which actually went beyond the prescribed period), and the remainder (with the exception of Bolivia, Colombia and Surinam) stay in office for approximately half of the prescribed period.[17]

[17] Those countries are: Argentina, Barbados, Belice, Bolivia, Brasil, Colombia, Costa Rica, Dominican R., Ecuador, El Salvador, Honduras, Jamaica, Paraguay, Peru, Surinam, Trinidad and Tobago and Uruguay. The average of legally prescribed periods is 54 months.

There is no precedent in the literature for measuring the independence in practice of TRA's. Drawing from the studies on Central Bank independence, we construct three variables that try to reflect the independence in practice through (i) the index of political vulnerability, that is, the number of months that elapse between a change in the country's executive power and a change in the head/director of the agency; (ii) the turnover rate, which measures the average actual duration in months of the regulator; and (iii) the practical independence index which gives a time-varying measure of independence which depends on the reason for which the head/director of the agency leaves his or her position.

Political Vulnerability Index

It is well known from the literature on Central bank independence that political changes may trigger changes in economic institutions.[18] As mentioned in the first section, Cukierman and Webb (1995) present an index of political vulnerability for Central Bank governors for countries all over the world. They argue that computing the turnover rate of the governor relative to political changes is important to evaluate the size and effect of these in the frequency of regulatory turnover. They think of this index as a measure of political influence. Thus, the formula of the index of (inverse) political vulnerability of TRA is defined for each country as the fraction of political transitions (characterized here as political changes as a result of which there is a new president or prime minister) that are not quickly followed by a replacement in the director/chair of agency:

$$V(i) \equiv \frac{\text{Number of regulators that stay in his or her position for } i \text{ months after a political transition}}{\text{Number of political transitions}}, \; i = 1, \ldots n$$

Cukierman and Webb (1995) use in the numerator the number of political replacements, whereas we use the number of regulators that stay in his or her position

[18] See Cukierman (1992), Cukierman and Webb (1995) and De Haan y Kooi (2000)

for *i* months after a political transition. The reason for the change is that we want to give a higher score to less political influence in TRA. When measuring turnover in the head of TRA's in Latin America, we find that in 61% of occasions there is a change in the head of the agency within 1 month. If we take six months, in 73% of times in which there is a change in president there is turnover in the head of the TRA. If we take one year, the ratio rises to 88%.

With the above mentioned information about turnover in TRA's, we have chosen one month after a political change in the country as period of analysis for our sample.[19] [20]

Among the weaknesses of the index of inverse vulnerability for TRA's, one is that it does not take into account those changes in the regulator during the remainder of the presidential period and which have a political motivation, be it because it took place after 1 month since the political transition, or because there has been more than one change of regulator during one president's period. In some of these cases, they are forced resignations for political motives or rivalries which do not involve a change in the executive.[21] There are also changes in the regulator due to cabinet reshuffles, promotions or resignations to run for elected jobs.[22] There are also interesting cases of directors who resign to find a job in the firms that they previously regulated, what is known in the literature as "revolving doors phenomenon".[23] These changes are not reflected in the index of inverse vulnerability, but a turnover rate or the frequency of changes would capture them. Another weakness of the measure is its failure to take into

[19] We chose one month because as reported most changes of regulator take place after 1 month.

[20] Barbados, Brazil and Jamaica are the only Latin American and Caribbean countries where the new country's president kept the same director at least for one year after taking office. In Dominican Republic, Ecuador, El Salvador and Guatemala when the president takes office, by law, the president must choose a new agency's head.

[21] One of the most representative cases is Argentina, where there have been 11 directors of regulatory agency CNC (previously CNT) in our period, and we only counted three for the index. Only in the presidency of Carlos Menem there were 7 different directors. The local press also reflects other cases of political pressures to force the resignation of the director, like in Bolivia, Brazil and Panama; or resignations due to differences amongst cabinet ministers, like in Chile; or resignations due to a change in party membership of the head of the agency, like in Nicaragua.

[22] We find examples in Mexico, where a director became cabinet minister; in Nicaragua and Venezuela two regulators became ministers. In Paraguay one agency head resigned to run for Parliament elections.

[23] In Nicaragua a Director General became executive of the country's subsidiary of the Spanish electricity firm Unión FENOSA. In Panama a former regulator founded and chaired a local and long distance telecommunications firm; in Colombia a former commissioner founded a consulting firm working for a cellular telephony firm; in Paraguay the government appointed the president of the agency as director general of the state-owned telecommunications monopoly. For an analysis of the revolving door phenomenon, see for example Che (1995) and Salant (1995).

account other forms of de facto influence of governments on regulators apart from removal of the agency head.

Another situation that is not measured in the vulnerability index are those cases where the head of the agency is a member of the Executive (vulnerability 0.00) but where the period in office in longer than the region's average, especially in countries with high stability in their cabinets and presidential periods.[24]

Turnover rate

The turnover rate measures the average actual duration in months of the time in office of the director or chair of the agency. It is a simple and interesting figure. In many cases, the regulator does not complete the prescribed period in office.[25] The average duration of a regulator in Latin American and Caribbean TRA's in the period 1990 to 2004 is approximately two years and a half, being those of lowest duration those in Colombia, Nicaragua and Argentina and those of highest duration those in Belize, Peru and Jamaica (see Table 3). Notice that the most stable countries are former British colonies and Chile.

The turnover rate does not distinguish amongst the reasons behind the change of the regulator. It only captures the effect of any type of changes, from the end of the legal period to resignations or removals for different reasons which diminish the effective time in the direction of TRA's relative to what is prescribed by law.[26] We also computed the frequency of change, which denotes the average turnover per year in the TRA's, a high frequency signalling continuous changes of regulator.

Note that the prescribed time in office can usually be evaded without violating the law, but clearly affecting the degree of independence.[27] If we focus on the 17

[24] Chile is the clearest of these cases. It has a low inverse vulnerability index, but the period in office of the telecommunications deputy secretary (the non-independent regulator, actually a cabinet minister) is longer than the region's average. For our period, in this country there has been only one regulator that has not finished his period with the country's president.

[25] There are some striking examples in the region. Argentina changed the regulator almost a dozen times since the creation of the agency in 1990, including two interventions (2002 y 2004) where the government removed the board and assigned a controller who took charge of the application of government's policy in the sector. In Ecuador, between 1995 and 2004 there were six presidents in the country and the same number of regulators.

[26] The local press mentioned colourful scandals around some turnover episodes, such as one of telephone spying related to France Telecom in El Salvador, or due to alleged nepotism in Panama, where the spouse of the private secretary of the country's president was appointed as regulator. There are also cases of removals in Mexico or Peru due to bad practices to benefit the incumbent firm.

[27] For example, in Costa Rica the general regulator is appointed by the executive by law and for the same period as the president, allowing for re-election, but there is no re-election for the country's president. In practice, the regulator has never been re-elected. Another potentially interesting issue is that the

countries which have a period established by law, only in four of them the regulator completed the full period: Belize, Jamaica, Uruguay and Peru (which actually goes beyond the prescribed period), and the remainder (with the exception of Bolivia, Colombia and Surinam), stay in approximately half of the prescribed period (see Table 4).

Table 4. Duration of TRA's heads by law vs. Turnover Rate (only countries with duration prescribed by law).

Period 1990-2004.

	Country	Legally prescribed (years)	Legally prescribed (months)	Turnover Rate (months)	Accomplishment
	Latin America (17)	*4*	*54*	*32*	*60%*
1	Argentina	5	60	16	27%
2	Barbados*	4	48	24	50%
3	Belice	6	72	72	100%
4	Bolivia	5	60	40	67%
5	Brasil	5	60	24	40%
6	Colombia	1.3	16	13	81%
7	Costa Rica	4	48	22	46%
8	Dominican R.	4	48	21	44%
9	Ecuador	4	48	20	42%
10	El Salvador	7	84	22	26%

retirement age can be a way to appoint an official for a short period of time, as the Pravas (2003) report suggests for the case of India. For Latin America and the Caribbean, only Belize prescribes 55 years old as the retirement age, but it has not affected the period in office of the regulator. There can also be changes in the regulator by changing the rules of the agency. For example, in the case of Mexico, a new president in the country can change the rules (something the executive can do) without being necessary to change the law and after changing the commissioners.

11	Honduras	4	48	18	38%
12	Jamaica	5	60	60	100%
13	Paraguay	5	60	22	37%
14	Peru	5	60	66	110%
15	Surinam	5	60	42	70%
16	Trinidad and Tobago	3	36	18	50%
17	Uruguay*	4	48	48	100%

*The years by law in Barbados are 5 and in Uruguay 6, but we only count 4, from its creation in 2001 to the final year of our simple, 2004.

Source: Computed by the authors

Practical Independence Index

Together with the information on dates of beginning and end of periods in office, we also obtained information on the reason publicly given for which the head of the agency left his or her position (the full list of reasons is available upon request). The index of independence in practice (PI) uses this information. It is computed as follows: we give a value of 0 when the regulator is dismissed or fired; we give a value of 1 to any other reason for leaving the position, except for those cases where the established period ends (change of government or disappearance of the agency); and we give a value of 2 when the regulator stays in his or her position to the end of the established period.

This index does not directly interact with political transitions, but makes it possible to have a time-varying index that includes information about all changes at the top of the agency.

The Index of Independence in Law and in Practice (LPI1 and LPI2)

The vulnerability index has a clear limitation when it comes to its use in statistical analysis: it is an average figure for all the studied period, so that it only takes one value for the fifteen years of the period. This limitation causes poor estimation results. In order to overcome this limitation, we have created an Index of Independence in Law and in Practice (LPI1), which combines the time-varying Index of Regulatory Independence (IRI) shown in Montoya and Trillas (2007)[28] and the index of inverse vulnerability, through the combination of both indices weighed at 50% each. As a result, the LPI is an index that varies over time and that captures the independence in law and in practice, being the first index of this type in the literature. It takes into account the same information as IR1 (or indices that are shown in Montoya and Trillas, 2007, to be highly correlated with this, such as the one presented in Gutiérrez, 2003a), and it adds for the first time information about the degree of independence in practice relative to the political majorities.

We also have created an Index of Independence in Law and in Practice (LPI2), which combines the time-varying Index of Regulatory Independence (IR1) and the practical independence index (which is also time-varying), through the combination of both indices. As a result, the LPI2 is an index that captures the independence in law and in practice, and which takes into account the reason why the head of TRA leaves the agency.

Rankings

Concerning the relative position of the 23 countries (see Table 4), some countries which occupy the first positions in the legal index (IR1) are also on top of the legal and practical indices (LPI1 and LPI2), such as Peru and Bolivia.

[28] IRI has 10 components: (i) Years of effective operation of the agency since its legal creation. (ii) Percentage of private ownership of the incumbent. (iii) Degree to which the regulatory agency has powers in the allocation of fixed telephony licences. Powers to (iv) set fixed line tariffs, (v) to allocate spectrum, (vi) in administering universal service. (vii) Budget independence. (viii) Term in office for regulators, (ix) Appointment rules; and (x) Dismissing powers. IRI is similar to the indices of Edwards and Waverman (2006) and Gual and Trillas (2006).

In general, the countries occupying the first places at LPI1 and LPI2 show a correct legal framework, and the longevity of some of their directors, together with the fact that turnover takes place long after political change and/or the head is not dismissed.[29]

The ten lowest positions are occupied by countries characterized by agencies that are part of a Ministry, so with little legal independence, and hence where independence in practice is meaningless (Chile and Surinam); or by rules prescribing that new governments must appoint regulators (Dominican Republic and Guatemala); or by a high politicization in the appointment of the head of the agency so that turnover is frequent (Nicaragua).

Concerning examples of countries that experience clear changes in their relative positions, we note that El Salvador for instance has a correct legal framework but a low level of independence de facto combined with the legal framework. Conversely, Jamaica has a low position in terms of legal framework, but a high position when this legal framework is combined with independence in practice.

Table 5. Ranking IR1, LPI1 and LPI2. 1990-2004 average.

#	*Country*	IR1	*Country*	LPI1	*Country*	LPI2
1	Argentina	0.647	Peru	0.581	Peru	0.947
2	Bolivia	0.487	Bolivia	0.577	Jamaica	0.793
3	Panama	0.459	Argentina	0.490	Colombia	0.774
4	El Salvador	0.441	Brazil	0.478	Bolivia	0.710
5	Peru	0.428	Venezuela	0.468	Argentina	0.590
6	Brazil	0.422	Jamaica	0.460	Panama	0.563
7	Paraguay	0.416	Honduras	0.443	Venezuela	0.557
8	Chile	0.400	Mexico	0.415	Belice	0.550
9	Ecuador	0.387	Paraguay	0.408	Paraguay	0.508
10	Nicaragua	0.371	Colombia	0.385	Costa Rica	0.485
11	Costa Rica	0.370	Panama	0.380	Mexico	0.448
12	Venezuela	0.314	Belice	0.350	Brazil	0.411
13	Belice	0.300	Barbados	0.265	Nicaragua	0.385
14	Honduras	0.286	Ecuador	0.260	El Salvador	0.354
15	Colombia	0.281	Trinidad and T	0.240	Trinidad and T	0.340
16	Trinidad and T	0.279	Uruguay	0.227	Chile	0.333
17	Barbados	0.264	El Salvador	0.221	Barbados	0.299
18	Jamaica	0.253	Chile	0.200	Dominican R.	0.258
19	Dominican R.	0.249	Costa Rica	0.185	Uruguay	0.227

[29] For example, Bolivia had one of the regulators that stayed in his position for longer, "surviving" to three different country presidents. Peru had one of the most stable agencies in the sub-continent, with only two regulators in 10 years.

20	Mexico	0.229	Nicaragua	0.181	Guatemala	0.225
21	Uruguay	0.187	Dominican R.	0.125	Ecuador	0.193
22	Guatemala	0.183	Guatemala	0.091	Honduras	0.143
23	Surinam	0.047	Surinam	0.023	Surinam	0.023

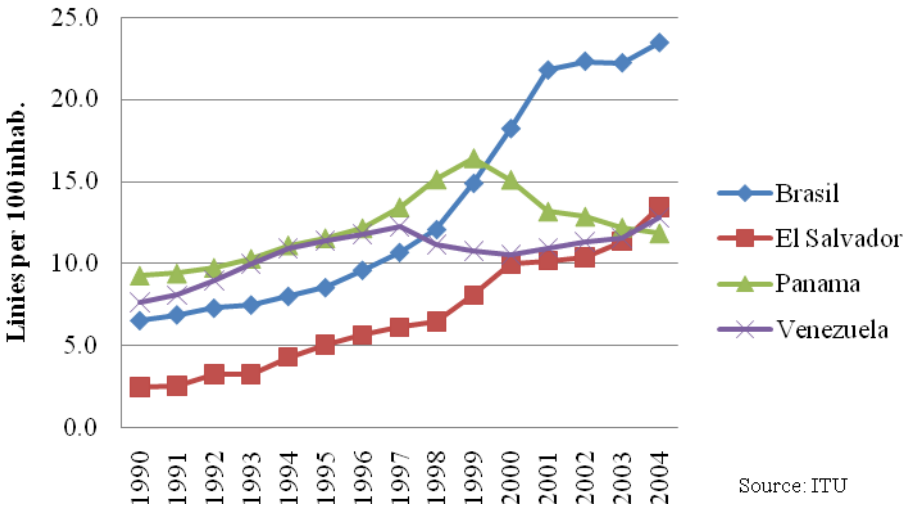
Source: Montoya & Trillas (2007) and authors calculations

4. The impact of regulatory independence on network penetration

4.1. Specification, data and cross section

We are interested in measuring the impact of regulatory independence on network penetration in fixed telephony. Although in developed countries access to a telephone line is usually taken for granted, this is not the case for many developing countries. In our region of study for our sample years (1990-2004), many countries had very low levels of telephone penetration to start with, and the cross country and time variation is high. Graph 1 shows for example the evolution of telephone penetration for Brasil, El Salvador, Panama and Venezuela. Of all these, the country that reached the highest growth was Brasil, still falling below the 25% level by the end of the sample period.

Graph 1. Main telephone lines per 100 inhabitants. Four LA countries



To analyze the impact of independence on telecommunications performance, the general model we use can be expressed as:

$$Y_{it} = B_{1it} + B_2X_{2it} + B_3X_{3it} + \ldots X_{kit} + \mu_{it} \qquad (1)$$

where $X_{it} = (X_{2it}, X_{3it}, \ldots X_{Kit})$ are the explanatory variables, including an independence index (IR1, LPI1 or LPI2) and control variables. $B = (B_1, B_2, \ldots B_K)$ are their respective parameters and μ_{it} is an error term. We use individual fixed effects for the 23 countries.

The error term is modelled as:

$$\mu_{it} = \mu_i + v_{it} \qquad (2)$$

where μ_i denotes non-observable individual effects and v_{it} denotes the remainder of the residual.

The performance dependent variable Y_{it} in equation (1) are fixed telephone lines for every 100 inhabitants, obtained from the International Telecommunications Union data base. The indices IR1,[30] LPI1 and LPI2 are our main explanatory variable of interest.

Along the lines of other work in this field we expect that network expansion can be potentially affected by the economic structure and industry institutions. For this reason we control for two economic structure variables: GDP measured in purchasing power parity per capita (GDPppp) and population density. We obtained those variables from the data base of the World Bank. We expect that an increase in income per capita and density are associated with higher demand for communications and telephone services.

Our starting point is a cross section regression of average telephone penetration over the sample period for each country, to average GDP per capita and average population density. This has an adjusted R square of 0.75, both coefficients are positive and significant despite a very low number of observations (23), and the p-value associated to the F test is 0. If we add as regressors either *lpi1*, *ir1* or *vul1* (the latter, not shown in the table) to this regression, the coefficients on gdp and density keep their sign and significance. In the regressions where *lpi1* or *vul1* are added, the coefficient on the independence variable is negative and non-significant, whereas the adjusted R square value barely changes. However, when the *ir1* index is added (see Table 6), this has a negative impact which is significant at the 10% level and the adjusted R square

[30] Gual and Trillas (2004 and 2006) find that the correlation between the equally weighed index and the one derived from principal components analysis is above 0.9. Based on this, in the rest of this study we use equally weighted indices, although recognising that there may be some residual multicolinearity between the original variables.

improves. This negative and weakly significant result is very similar to that found by Gual and Trillas (2004) for a different group of 37 countries in a cross section exercise. The negative relationship between *ir1* and lines penetration may be due to reverse causation: when line penetration is very low, the marginal productivity of independence increases and this may encourage policy makers to increase independence. This coefficient ceases to be significant when *ir1* is instrumented by *polconiii* (an index[31] of political and institutional constraints developed[32] by Henisz and Zelner),[33] but the Hausman test indicates that the difference between OLS and IV coefficients is not significant (although the IV coefficients are lower in magnitude, though still negative). However, with such small sample, the usefulness of IV is very doubtful, since it has good properties only asymptotically.

Table 6. Parameter Estimates for Main Lines per 100 Inhabitants.

23 Countries, average values 1990-2004. Cross-Section

	OLS	*OLS*	*IV*
Regressors	*1*	*2*	*3*
IR1	-11.903*		-7.9605
t	-1.80		-0.57
LPI1		-3.826	
t		-0.61	
GDPpc	0.003***	0.003***	0.003***
t	6.58	6.01	6.30
Density	0.014*	0.015*	0.015*
t	2.05	1.97	2.03
Instrument			*polconiii*
Adjusted R-sqr	0.7811	0.7489	0.777
N-obs.	23	23	23

Notes. *** Statistically significant at 1%. ** Statistically significant at 5%. *Statistically significant at 10%.

[31] The data base on "policy constraints" due to Henisz (2000) is based on four variables that help estimate the probability of policy reversal for the period between 1900 and 2004, for 234 countries.

[32] For the study of the privatization, liberalization and regulation of telecommunications, it has been used by Henisz and Zeller (2001), Gual and Trillas (2004 and 2006) and mentioned by Gutierrez (2003b) and Jamison et al. (2005). Henisz, Zelner and Guillen (2005) create and use a data base with three variables to measure (formal) regulator independence, competition and privatization for 205 countries in the period 1960-1999. Both data bases can be obtained in http://www-management.wharton.upenn.edu/henisz/

[33] *Polconiii* has a 0.5 correlation coefficient with ir1 and a -0.1 correlation coefficient with lines penetration. The correlation coefficient between lines penetration and vul1 is 0.1. This is surprising, since one would expect that legal independence is a substitute for other constraints (for example, Chile does not need independence because it has other constraints), but that other constraints help to keep in practice whatever level of legal independence is prescribed by law. The results rather indicate that legal independence is on average a complement of other constraints.

4.2. Static panel data

We report static panel data estimates with country fixed effects instrumenting for independence and not instrumenting for it (Table 7). We use five indices of independence:

-*IR1*, a legal independence index similar to the one used in Gual and Trillas(2004).

-*PI*, the index of vulnerability of the regulators that varies with time presented in the previous section.

-*LPI1*, which multiplies IR1 and the vulnerability index at one month reported in the previous section.

-*LPI2*, which multiplies IR1 and PI.

-*LPI3*, an index that adds an equally weighted sum of the eleven original components of *IR1* plus the vulnerability index.

In all regressions, we control for GDP per capita in purchasing power parity and for density. Both have a positive and significant impact in all regressions.

As it can be seen from the results, adding issues of "independence in practice" to a legal independence index changes the magnitude of the impact but not the sign or the statistical significance. In a static panel, the impact of regulatory independence on network penetration is positive and significant. When other institutional variables are added as regressors (such as *reg*, *polconiii* or *checks*: these are respectively a measure of overall regulatory quality obtained by the World Bank, the constraints index built by Henisz and Zelner, and an index of checks and balances also developed by the World Bank) the results of independence do not change (not reported in the table). When both an index of independence in practice (namely, the one that varies over time, *PI*), and an index of legal independence are included as regressors (columns 5 and 10), both have a positive and significant impact, and the impact of the legal index is higher in magnitude.

In addition to the independence indices used in table 7, when we do *allphalf* (an index that gives half the weight to ir1 and the other half to the vulnerability index) without instrumenting the coefficient is 6.481195, which statistically is highly significant. In the regressions where independence is considered exogenous, the R square is the within R square. In the regressions where independence is endogenous the R square is the centered R square, as reported by Stata.

Table 7. Parameter estimates for main lines per 100 inhabitants. 23 countries. 1990-2004. Panel Data, country fixed effects.

Regressors	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*
LPI1	6.561***					12.307***				
z	7.78					7.34				
LPI2			2.165 ***					7.67 ***		
z			4.47					5.93		
LPI3				5.525***					8.783***	
z				7.07					7.39	
PI					.6962**					4.489*
z					2.28					1.65
IR1		5.268***			4.152***		8.997***			-.771
z		6.55			4.43		7.23			-0.13
Density	.1809***	.113***	.1867***	.1143***	.124***	.163***	.051	.1502***	.0632**	.1614*
z	7.42	4.02	7.23	4.16	4.36	6.20	1.55	4.77	2.02	2.25
GDPpcpppr	.0023***	.0025***	.0024***	.0025***	.0023***	.0018***	.002***	.0013***	.0022***	.0014*
z	8.51	9.14	8.21	9.01	8.32	5.88	7.82	3.12	7.75	2.10
R-sqr	0.5443	0.5222	0.4897	0.5312	0.5299	0.4779	0.4899	0.2823	0.5057	0.2975
N-obs.	344	344	344	344	344	344	344	344	344	344
Instruments	---	---	----	----	----	*efi, staff*	*efi, staff*	*efi, staff*	*efi, staff*	*efi, staff, polconiii* (weak)

Notes. * statistically significant at 1%. ** statistically significant at 5%. *** statistically significant at 10%.
Hausman Test of Ho: † Fixed Effects vs Random Effects. ‡ The explanatory variable is not endogenous.

The first 5 regressions assume that regulatory independence is exogenous. But regulatory independence may be correlated with the error term for the following reasons:

-Measurement error, both because in international comparisons we may be comparing slightly differing dimensions and because in aggregating through an index we may assign arbitrary weights.

-Reverse causality, because as mentioned in the cross section exercise, a low penetration level may trigger measures to increase penetration, such as regulatory independence.

-Omitted regressors, because institutions or social preference may at the same time be causing a high penetration level and a high level of independence.

Hence, since we were suspicious of potential endogeneity problems in our independence measures, in columns 6-10 we endogenize the independence indices by two politico-institutional variables, *efi* (economic freedom index, an index developed by the Fraser Institute) and *staff* (a relative measure of the size of the incumbent operator). In column 3 we need an additional instrument to run the overidentification test, and we use *polconiii*. Except in column 10 where the instruments turn out to be weak, in all the other tests the instrumental variable estimates are higher in magnitude than the estimates computed without instrumenting. Using the *LPI1* index, for example, the regression results treating independence as exogenous imply that, if the model is correct, when a country has the independence level in 2004 of the highest country in the ranking (Peru), it has 4 more lines per 100 inhabitants than when it has the independence level of the lowest country in the ranking, Costa Rica, everything else constant. However, if independence is (correctly) treated as endogenous, the impact of the difference is to have 7.6 more lines. We conclude that treating regulatory independence as exogenous may substantially underestimate the impact of independence on network penetration. However, finding good instruments is difficult, since only in the regression in column 6 the instruments were fully convincing, at least in the narrow sense of passing the overidentification Sargan test and a weak exogeneity

test, although in all cases the null hypothesis of exogeneity was rejected using the Hausman test.[34]

In column 6, the Crag-Donald Wald F statistic of weak exogeneity of the instruments is 63.846, which is above the Stock-Yogo critical value at 10% of 19.93, meaning that the hypothesis of weak exogeneity is rejected. The Sargan statistic of overidentification is 1.04 with a P-value of 0.3060, which does not reject that the instruments are uncorrelated with the error. Finally, the chi-square value of the Hausman test is 15.70, with an associated p-value of 0.0013, which rejects the hypothesis that there is no difference between the IV estimates and the conventional panel data estimates.

In column 7, the Crag-Donald Wald F statistic of weak exogeneity of the instruments is 125.081, which is above the Stock-Yogo critical value at 10% of 19.93, meaning that the hypothesis of weak exogeneity is rejected. The Sargan statistic of overidentification is 3.920 with a P-value of 0.047, which does not reject that the instruments are uncorrelated with the error, but only at the 5% level. Finally, the chi-square value of the Hausman test is 15.3, with an associated p-value of 0.0015, which rejects the hypothesis that there is no difference between the IV estimates and the conventional panel data estimates.

In column 8, the Crag-Donald Wald F statistic of weak exogeneity of the instruments is 38.516, which is above the Stock-Yogo critical value at 10% of 19.93, meaning that the hypothesis of weak exogeneity is rejected. The Sargan statistic of overidentification is 4.722 with a P-value of 0.02, which does not reject that the instruments are uncorrelated with the error, but only at the 5% level. Finally, the chi-square value of the Hausman test is 21.09, with an associated p-value of 0.0001, which rejects the hypothesis that there is no difference between the IV estimates and the conventional panel data with fixed effects estimates.

In column 9, the Crag-Donald Wald F statistic of weak exogeneity of the instruments is 131.131, which is above the Stock-Yogo critical value at 10% of 19.93, meaning that the hypothesis of weak exogeneity is rejected. The Sargan statistic of overidentification is 3.288 with a P-value of 0.0698, which does not reject that the instruments are uncorrelated with the error, but only at the 5% level. Finally, the chi-square value of the Hausman test is 13.27, with an associated p-value of 0.004, which

[34] Other instruments such as *reg* and *checks* were tried, but the test results were even weaker.

rejects the hypothesis that there is no difference between the IV estimates and the conventional panel data with fixed effects estimates.

In column 10, the Crag-Donald Wald F statistic of weak exogeneity of the instruments is 1.931, which is below the Stock-Yogo critical value at 10% of 13.43, meaning that the hypothesis of weak exogeneity is not rejected in this case. The Sargan statistic of overidentification is 4.089 with a P-value of 0.04, which does not reject that the instruments are uncorrelated with the error, but only at the 5% level. Finally, the chi-square value of the Hausman test is 7.79 with an associated p-value of 0.05, which rejects the hypothesis that there is no difference between the IV estimates and the conventional panel data with fixed effects estimates.

The data confirm that more realistic measures of independence still have a positive and significant impact on network penetration. Although the coefficients measuring legal or legal and practice independence have different magnitude we do not want to over-emphasize this difference at this stage, since we are aware that as with any index, the components and weights are to some extent arbitrary. We only point out here that, with this preliminary analysis (which bring the empirical literature on regulation one step closer to the more advanced empirical literature on Central Bank independence) regulator independence matters, even when we take into account the problems that governments face of committing to respect the independence of the regulator.

4.3 Dynamic panel

In a dynamic panel estimation (adding lagged penetration as a right-hand side variable), *ir1* and *lpi1* have a positive non significant impact (see Table 8).

The results show that when adding the lag dependent variable, independence and the other variables lose explanatory power, although they still have the same sign. In this case, instrumenting for *ir1* does not yield a significantly different result, although the coefficients are again higher when independence is treated as endogenous (and the overidentifying and weak exogeneity test yield positive results). The Stata output warns that, along the lines of Kennedy (2008, chapter 9), the rank of the differenced variance matrix does not equal the number of coefficients being tested; in this case, there may be problems computing the chi-square version of the Hausman test. The same happens when we use *lpi1* as the independence index. Future work will consider scaling your

variables so that the coefficients are on a similar scale or running the other versions of the Hausman test suggested by Kennedy (2008).

Table 8. Parameter estimates for main lines per 100 inhabitants. 23 countries. 1990-2004. Panel Data, country fixed effects.

Regressors	*1*	*2*	*3*	*4*	*5*	*6*
Lines100-1	.9286***	.9308***	.926***	.9212***	.9117***	.9317***
z	56.19	54.63	55.78	51.34	41.33	33.92
LPI1		0.212			1.006	
z		0.74			1.56	
PI			0.1269			-1.546
z			1.36			-1.5
IR1	0.3382		0.1479	0.654		3.895*
z	1.31		0.5	1.56		1.87
Density	.0162*	.0208**	.0184**	0.0123	.022***	-0.025
z	1.87	2.56	2.08	1.28	2.69	-0.95
GDPpcpppr	.0002*	.0002*	0.0001	.0002*	.0002*	0.0005
z	1.93	1.91	1.65	1.92	1.77	1.99
R-sqr	0.9564	0.9562	0.9567	0.9562	0.9552	0.9094
N-obs.	344	344	344	344	344	344
Instruments	---	---	----	*efi, staff*	*efi, staff*	*efi, staff, polconiii*

When both a legal index and a practice index for independence are introduced as independent regressors, neither of them are significant when treated as exogenous, although they enter with a positive sign. When treated as endogenous, the instruments in this case are weak according to the Stock-Yogo critical values, and the chi-sqaure Hausman test does not reject that independence is exogenous, although with the same computational problems as the ones mentioned for ir1 and lpi.

5. Conclusions

This article takes the suggestion made in the conclusions of several empirical studies on the measurement and impact of regulatory independence, and makes the first effort to measure the practice of regulatory independence in TRA's. The literature has evolved from a seminal stage where independence was measured using a dummy 0-1 variable, to a stage where the use of legal *de jure* independence indices has become quite common. Gutierrez (2003a) is perhaps the study that has made most progress along these lines.

We take this evolution one step forward, by

i) Obtaining detailed information about the practice of independence in 23 Latin American and Caribbean countries between 1990 and 2004.

ii) Constructing with this information indices of independence that combine legal and practice issues, borrowing from the methodology used in the Central Bank Independence literature.

iii) Quantifying the impact of this better measured regulator independence on network penetration for telecommunications markets.

For example, the legal indices used so far computed the prescribed number of years that the head of agency was allowed to stay in office. With our index, we correct this legal prescription with the actual time period that the regulator is in office. Estimation results confirm that regulator independence is associated to higher network penetration in Latin American and Caribbean telecommunications markets, but the magnitude and statistical significance of this impact are probably low and difficult to assess. Besides this, treating independence as exogenous, as done so far in the literature, may underestimate the impact of regulatory independence.

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