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TELECOMMUNICATIONS POLICIES:
DETERMINANTS AND IMPACT

Jordi Gual *
Francesc Trillas**

* Professor of Economics, IESE

** Universitat Autònoma de Barcelona

IESE Business School - Universidad de Navarra

Avda. Pearson, 21 - 08034 Barcelona. Tel.: (+34) 93 253 42 00 Fax: (+34) 93 253 43 43

Camino del Cerro del Águila, 3 (Ctra. de Castilla, km. 5,180) - 28023 Madrid. Tel.: (+34) 91 357 08 09 Fax: (+34) 91 357 29 13

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TELECOMMUNICATIONS POLICIES: DETERMINANTS AND IMPACT

Abstract

This paper presents new data, in the form of four indices, on liberalization policies and the independence of regulators for a cross-section of countries. These indices are combined with a comprehensive set of performance, institutional and political data to analyze both the determinants and the impact of telecommunications policies. We find that liberalization policies are negatively associated with the degree to which countries have an interventionist tradition, but not with the partisan ideology of reforming countries per se. We also find that countries where the institutional endowment constrains less the behaviour of the executive bodies, and countries with a stronger incumbent, are more prone to create truly independent regulatory agencies. There is weak evidence that the creation of independent regulatory agencies has a positive effect on network penetration when we take into account the endogeneity of regulatory independence.

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TELECOMMUNICATIONS POLICIES: DETERMINANTS AND IMPACT (1)

Introduction

The last years of the twentieth century were very rich in reform initiatives in the telecommunications sector. Many countries introduced private ownership of the dominant operators, liberalized at least some segments of the industry and introduced new regulatory authorities. Regulatory reform has, however, many dimensions and takes different forms across countries.

The objective of this study is to measure the reform processes taking into account such multi-dimensionality, and to analyze both the determinants and the impact of reform initiatives. We focus on liberalization policies (in particular, the degree to which market opening or deregulation policies are asymmetric, or biased in favour of entrants) and the degree of independence (vis-à-vis their governments) of regulatory authorities. We present four new indices, two for asymmetric deregulation and two for independence. They summarize information on a large number of original variables relevant to these policy areas.

Although there is a broad consensus among scholars and international institutions (such as the World Bank, the OECD, the International Telecommunications Union, the European Commission) that opening up the telecommunications sector to competition is both possible and beneficial for social welfare, the precise nature of this liberalization process is still controversial. Many of the controversial issues can be summarized in one question: to what extent should the liberalization policy favour entrants relative to incumbents? In other words, how biased or asymmetric should regulation be in the market-opening phase? Incumbent operators have huge incumbency advantages in most countries and enjoy significant scope economies, since they operate in several segments of the industry. However they also carry the burden of funding universal service and are the main providers of infrastructure. Asymmetric regulation may lead to regulators favouring certain competitors rather than more competition, allowing the entry of inefficient firms and imposing unnecessary constraints on incumbents.

Much the same can be said of the related issue of regulatory independence. Although scholars and international institutions advocate the establishment of independent regulators,

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there is less debate and consensus on the particular attributes of independent regulators and on how to make independence sustainable. On this, we can draw on the academic literature on Central Bank independence, which analyzes the problem using aggregate indices that take into account several dimensions of independence. We take a first step in this direction for telecom regulators. It is an important step in our view, insofar as the previous empirical literature has only measured regulator independence as a binary *dummy* variable.

We evaluate the incidence of policies (asymmetric regulation and regulatory independence) on telecommunications performance, measured by network penetration and productivity. Comparative assessment of telecommunications reform is an active area of research (2). Our contribution to this growing literature is threefold:

First, we put our original indices to work, so that our policy variables and our estimates reflect (for the first time in the case of independence) the fact that both liberalization and regulatory independence are multi-dimensional phenomena.

Second, along the lines of the recent empirical literature on political economy (3), we take into account the potential endogeneity of policies.

Third, we use a battery of institutional indices that have not been used in a combined, systematic way in the rest of the literature (4). By doing so, we are able to assess the relative explanatory power of each index, and relate them to policies and performance in telecommunications.

Among our preliminary results, we find that entry policies are negatively associated with the degree to which countries have an interventionist tradition, but not with the partisan ideology of reforming countries *per se*. We also find that countries where the institutional endowment (5) constrains less the behaviour of the executive bodies are more prone to create truly independent regulatory agencies. There is weak evidence that the creation of independent regulatory agencies has a positive effect on network penetration when we take into account the endogeneity of independence.

The paper is organized as follows: Section 2 presents the specification strategy, the hypotheses and the relationship with the existing literature. Section 3 describes the data. Section 4 shows and discusses the results obtained with this data set, and we end up with some concluding remarks.

2. Model Specification

To analyze the effect of specific telecommunication policies and regulatory institutions on industry performance, we use a simple reduced-form model that relates industry outcomes to a set of supply and demand control variables and the policy and

(2) See Ros (2002), Wallsten (2001), Fink et al. (2002), Boylaud and Nicoletti (2000), Li et al. (2002).

(3) See Besley and Case (2000), Röller and Duso (2001), Beck et al. (2001).

(4) See LaPorta et al. (1999 and 2002), Kaufmann and Kraay (2002), Henisz and Zelner (2000a and b).

(5) The institutional endowment is the set of formal and informal rules that constrain the behaviour of citizens in society. Examples of elements of the institutional endowment are whether the system is presidential or parliamentary, the degree of proportionality in the electoral rules, the quality and efficiency of the civil service or the judiciary, etc. (see Levy and Špiller, 1996).

institutional variables of interest (equation (i) below). This specification takes into account the special features of the telecommunications sector.

When confronted with the decision to open the industry to competition, the entry barriers faced by new operators are a decisive factor that has to be taken into account. Policy makers may use a number of tools to favour the entrants. Hence the policy variable, measured with an *asymmetric deregulation* index, will reflect the extent to which telecommunications policies are biased in favour of entrants relative to incumbents (a larger value of the index will indicate a more asymmetric policy). The sign of the parameter corresponding to this policy variable is a matter of controversy. Some authors have criticized the policies that facilitate the entry of new firms, and argued that this policy hurts the performance of the industry since, by constraining the behaviour of the incumbents, economic efficiency is hampered due to the insufficient exploitation of scope economies and the reduction of the pace of innovation. An institutional variable will capture the effect of regulatory independence on industry performance.

Since there may be unobserved heterogeneity in the form of policies and institutions being correlated with omitted variables that are also correlated with performance variables, we will also estimate an equation for the policy and institutional variables (equation (ii)).

The specification we use is the following:

- (i) $q = g(\text{Demand, Costs, Market Structure, } s) + v$
- (ii) $s = h(\text{Political Institutions, Interest groups, } q_{-1} \dots) + u$

where q are the industry outcomes and s are the policy and institutional variables to be explained; h and g are functions and u and v error terms. The set of variables s includes both market-opening policies and the independence of regulatory institutions. In equation (ii) we include lagged performance variables to take into account the potential causal link between better industry outcomes and better future policies.

In equation (i), the original policy variables are considered as potentially endogenous and we use instrumental variables (using the insights gained from the estimation of equation (ii)) to solve the problem of the correlation of the explanatory variable with the error term. It has been suggested that the use of political variables (following Besley and Case, 2000) as instruments may help to achieve consistent estimators in the presence of endogeneity. Indeed, our specification boils down to tackling the endogeneity issue through the use of instrumental variables, such as political variables, both for policies (in this case, deregulation policies in telecommunications) and regulatory institutions (in this case, the independence of the telecom regulator). (6)

(6) Previous studies fail to take into account the endogeneity of policies. However, Röller and Duso (RD, 2002) undertake an insightful exercise using political variables as instruments and find that the results of the previous literature on the effects of deregulation (particularly the OECD studies) are no longer valid. However, they treat regulatory institutions as exogenous, whereas, at least in telecommunications, they are as endogenous as liberalization policies themselves, and are often decided upon at the same time. Moreover, among the variables that explain the policy choice they do not include interest groups, which happen to be an important determinant of liberalization and regulatory reform in other studies (see Henisz and Zelner, 2000b).

In equation (i) it is also very important not to omit any regressor that has a simultaneous and independent influence on policies, regulatory institutions and outcomes (for example, institutional indices of political risk, expropriation risk, political constraints, etc.). In econometric terms, one must have a regressor that is correlated with policies, and use as instrumental variable the part of this variable that explains policies (and institutions) and not directly the economic outcomes that one wants to analyze. The unobservable variables that may affect both policies and outcomes must be controlled for. This is particularly important in equation (i), since this is a reduced-form equation that summarizes the supply and demand equations that determine the market equilibrium.

With this specification strategy in mind, we test a number of hypotheses derived from the literature on political economy and regulation.

Hypothesis 1) Market-opening policies are negatively associated with the interventionist tradition of each country, and positively related to the weight of interest groups and the partisan ideology of the reforming country.

First, policies are typically associated with institutional traditions. Deregulation policies will be more ambitious in countries with a less interventionist tradition (LaPorta et al., 1999 and 2002). Second, many policies have been observed to be partisan, i.e. different political parties, since they represent different constituencies, will implement different policies (Alesina and Rosenthal, 1995). Right-wing coalitions/governments, according to this, emphasizing free markets rather than redistributive policies, will be more prone to deregulate and create an environment that is favourable to private investment in telecommunications. And third, policies will be influenced by interest groups, which compete in the political arena to obtain favourable policies (see Peltzman, 1976, and Grossman and Helpman, 2001).

Hypothesis 2) The setting up of truly independent regulatory agencies is a policy decision itself, which depends on the institutional endowment of each country and the interest of dominant interest groups in the outcomes of this institutional setting relative to the alternatives.

The explanatory variables for equation (i) will include a number of institutional indices. These political variables influence the choice of policies (market-opening policies as well as regulatory institutions). These institutional indices will be used also in equation (ii), and could in some cases also have a direct influence on market outcomes. Using this specification, one can test, for example, whether regulatory independence is necessary or redundant (and hence socially too expensive) once the country has other ways to enforce contracts and credibly commit to stable policies. Levy and Spiller (1996) and Henisz and Zelner (2000b) argue that the creation of independent agencies is one among several options available to countries that want to commit credibly not to expropriate the sunk investments that characterize network industries. Whether this option will be exercised or not depends on the institutional endowment and the structure of interest groups.

Hypothesis 3) Market-opening policies have a positive effect on productivity and independent agencies have a positive effect on investment.

There is a general consensus that competition in the non-natural monopoly segments of telecommunications is both possible and beneficial for social welfare, especially through improvements in incentives and productivity. Some scholars think, however, that there is a thin line that should not be crossed between promoting competition and protecting particular competitors that may not be as efficient as the incumbent firms. In addition to this argument,

these scholars also warn against the danger of expropriating the dominant operators' sunk investments in infrastructures (7). Other scholars emphasize the potential for strategic delegation to relatively pro-industry regulators, in an analogy with strategic Rogoff delegation to conservative central bankers in monetary policy (Levine et al., 2002). Pro-industry regulators (or regulators who have a duty to behave in a "pro-industry" way) would not expropriate sunk investments.

3. Data

3.1. *Telecommunications policy variables*

We collected data on a number of original variables reflecting telecommunications policies and institutions in 1998 for 37 countries. This new data set, and the way we summarize it through indices, is one of the main contributions of our work. The description and measurement technique of these original variables can be found in **Appendix 1**. We aggregated the original variables in 4 indices, two for asymmetric deregulation and two for independence. These aggregation techniques are summarized below and more detail is provided in **Appendix 2**. The values that the indices take for each country can be found in **Appendix 3**. The construction of the indices can be easily replicated. Alternatively, the original variables can be combined in different ways according to the purposes of other researchers. We make the data on the observations for the original variables available.

Data have been collected from web pages, legislative texts published by the different regulatory authorities, documents and working papers of the OECD and the International Telecommunications Union (ITU), studies carried out on behalf of the European Commission, and articles from specialized journals.

The two indices on asymmetric deregulation policies (entry and entry(pc)) aggregate information on the following policies:

- The degree to which entry in the industry is subject to investment conditions of any kind.
- The average of the number of mobile providers in 1996 and 1997.
- The method of spectrum allocation.
- The existence of number portability in fixed and mobile telephony.
- The existence of carrier selection and carrier pre-selection in local, long-distance and international telephony.
- The rules governing mobile to mobile and fixed to mobile interconnection rates.
- The availability of local loop unbundling and rules governing access to alternative infrastructure.

(7) See Sidak and Spulber (1997).

We have associated a metric to each of these variables, with the lowest value for policies that are less favourable to ease of entry and a higher value to policies that are more favourable. These values have been aggregated into two indices, namely *entry* and *entry(pc)*. The difference between *entry* and *entry(pc)* is that whereas the former is an ad hoc index that just adds up the values in all the “asymmetric deregulation” dimensions that have been considered, the latter is chosen among four new variables that summarize all the observations in these dimensions using principal components analysis. The new variable reflects mostly the introduction of number portability in fixed telephony, the absence of investment conditions for entrants, the presence of long-distance and international carrier pre-selection, and the introduction of local loop unbundling. For this reason, we think that this new variable describes well the degree to which regulation is asymmetrically biased in favour of entrants.

Of the 37 countries for which we collected information, 33 had a separate regulatory agency in operation in 1998 (all except Chile, Japan, New Zealand and Israel). Of these, 18 had set up the regulatory agency prior to 1997. In this year, as many as 11 agencies started operating, and four of them started in 1998. The oldest agency is the FCC of the US, which started operating in 1934, and the next one at the national level was not created until 1976 in Canada. All the others were created in the 1990s. Therefore, the establishment of separate regulatory agencies is a very recent phenomenon.

The two indices on regulatory independence (*indep* and *indep(pc)*) are based on information which covers the following issues:

- The degree to which the regulatory agency is responsible for a number of policies, including: licensing, interconnection, tariffs, scarce resource allocation (such as spectrum frequencies and numeration plans), and universal service.
- The degree to which its funding sources are independent of the government’s discretion.
- The rules of appointment of the head of the agency or its board.
- The length of the term in office of the head of the office or the members of the board.
- The rules about obligations to report to the government, parliament or some other official body.

We have associated a metric to each of these variables, with the lowest value for policies that give less independence to the office and a higher value to policies that give more independence. These values have been aggregated in two indices, *indep* and *indep(pc)*. The difference between *indep* and *indep(pc)* is that whereas the former is an ad hoc index that just adds up the values in all the “independence” dimensions that have been considered, the latter is chosen out of the three new variables that summarize all the observations in these dimensions using principal components analysis. This new variable reflects mostly the regulator’s capacity to set tariffs and interconnection charges and, to a lesser extent, its independence of the government in terms of funding and length of term in office.

3.2. Telecommunications performance variables

Data on the performance of the telecommunications industry was obtained from the International Telecommunications Union (ITU) database. We focus on performance as measured by network penetration and productivity data.

Network penetration is described as main lines per 100 inhabitants (*linesinhab*). We focus on the level of this variable in 1998 and 2001. This is the last year available. We also consider the rate of growth since 1998, the year for which we computed the policy measures.

Productivity is measured as subscribers per employee and main lines per employee. For both we use the levels in 2000 (*subworker* and *linesworker*), the last year available, and the growth in the subscribers per worker variable between 1998 and 2000. When these variables are lagged, the data correspond to 1994.

3.3. Political and institutional variables

We have collected a number of political variables on the general quality of government, interest groups, ideology, institutions and the tradition of each country with regard to the state's involvement in the economy.

Our ideological variable *ideology* has a value of one if the largest party in the government was a right-wing party as of January, 1st 1997, and a value of zero if the largest party had any other orientation. We elaborated this variable from the original Beck et al.'s (2001) data set (8).

We have two variables reflecting the interventionist tradition of each country, i.e., the degree to which the state has an inclination to intervene in economic matters. Both of them are collected from LaPorta's web page at the Economics Department of Harvard University. One of them, *legal*, reports whether the legal origin of the country belongs to English Civil Law or to other more interventionist traditions, such as socialist, French Common Law, German Common Law or Scandinavian Common Law. LaPorta et al. (1999) argue that this variable proxies for the degree of interventionism of the state in economic matters, since English Civil Law was set up to protect the owners from the sovereign, whereas traditions such as French Common Law were designed to reinforce the role of the state. The socialist tradition would be an extreme case of interventionism and the other two would be intermediate cases between English and French. We give a value of 0 to 4 in the order of more interventionist to less (so the order is socialist, French, German, Scandinavian, English). Moreover, this variable is interesting as a potential instrument because it is exogenous and uncorrelated with performance in telecommunications, since the legal origin is usually associated with colonization or conquest. The other measure of interventionism, *procedures*, is the number of steps that a new business has to take in order to start operating, and it is obtained from LaPorta et al. (2002).

(8) The original data set on ideologies by Beck et al. labels the largest party in each country's government as left, center, right or non-applicable. However, the way they allocate the left or center label to different largest parties seemed to us somehow inaccurate. For example, they attach the label left both to the Cuban and to the Clinton government in the US, whereas the Prodi administration in Italy and the center-left ruling coalition in Chile are allocated the Center label. The way they allocate the right label seemed to us more clear cut.

We have some variables reflecting the weight of some interest groups in the policies of interest, although this clearly is an area that can be expanded in future research. We have the number of telecommunications workers divided by the overall population (*staff*) as a measure of the size of the incumbent, and the percentage of urban population (*urbanpop*) as a measure of the size of a social group demanding new services and hence *a priori* in favour of telecom liberalization (9).

We have three variables reflecting the general quality of government, obtained from Kaufmann and Kraay (2002). These are *regqual*, *goveff* and *rulelaw*, and they are composite indices measuring, respectively, the general quality of government, government effectiveness and the rule of law.

And we have one additional variable, *instconst*, which is an index of institutional constraints on executive bodies, first used in Henisz and Zelner (2000). We use the average for this index between 1945 and 1975. This index gives a measure of the ability of governments to commit themselves or their successors not to expropriate investments.

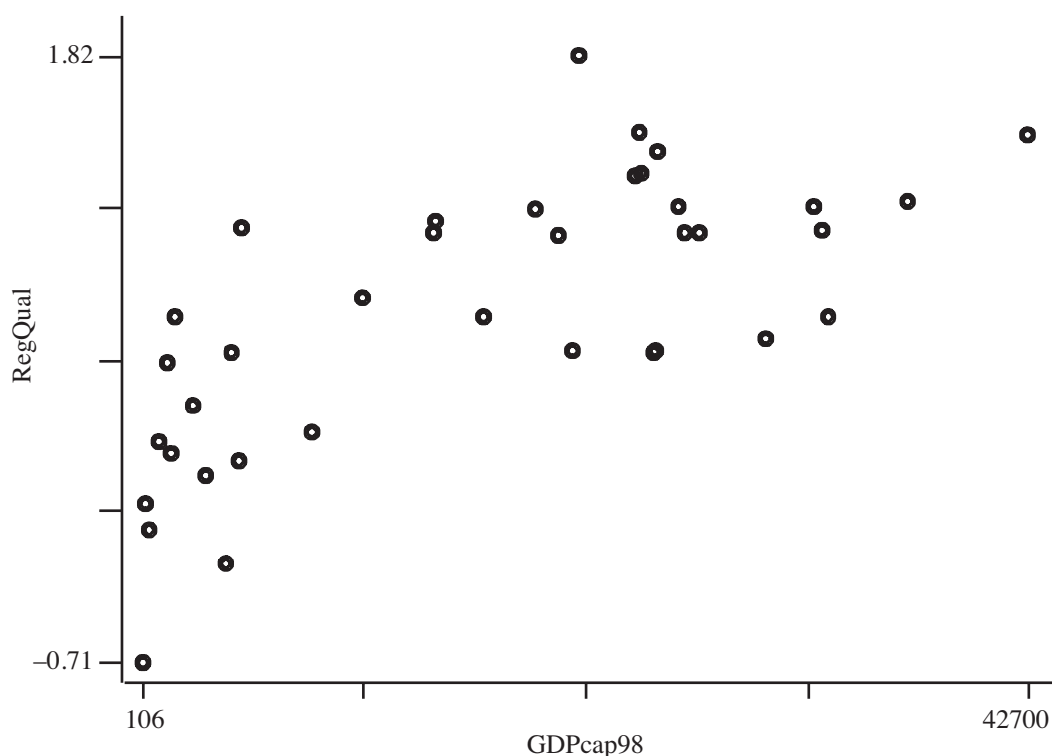
Table 1 reports the correlation matrix of these institutional and political variables for our observations, plus our two indices of regulator independence, *indep* and *indep(pc)*. The table clearly shows that these variables are measuring different phenomena, and that not taking some of them into account may lead us to omit some important influences in the analysis. The rule of law index, the government effectiveness index and the regulatory quality index are highly positively correlated. The legal origin and the number of procedures to set up a new business are highly negatively correlated. Surprisingly, our two indices of regulatory independence are not highly correlated with any of the other institutional indices. We tackle this issue more in depth below, when we discuss our preliminary results.

Table 1. Correlation between sector-specific and general regulation variables

	regqual	indep	indep(pc)	goveff	rulelaw	legal	instconst	procedures
regqual	1							
indep	0.1078	1						
indep(pc)	0.0493	0.7080	1					
goveff	0.9221	0.1246	0.0093	1				
rulelaw	0.8743	-0.009	-0.087	0.9285	1			
legal	0.4439	-0.013	-0.275	0.4823	0.4963	1		
instconst	0.3558	-0.027	-0.161	0.4971	0.5447	0.6194	1	
procedures	-0.639	-0.028	0.0845	-0.648	-0.664	-0.775	-0.6393	1

We also have data on the GDP per capita in 1998 in dollar terms to control for the level of development in each country, which may also influence telecom performance. There is a high correlation between regulatory quality (and also government effectiveness and rule of law) and GDP per capita. The following graph points to a non-linear positive association between the two:

(9) Both measures correspond to 1994.



4. Econometric results

4.1. The determinants of endogenous policies

Tables 2a-d show that legal origins and lagged performance are significant determinants of the entry index. Our estimations are consistent with the hypothesis that less interventionist societies tend to liberalize more, and impose a regulation which favours the incumbents to a lesser degree. Societies with better telecommunications sectors also tend to liberalize more. Interestingly, however, the principal components index of asymmetric deregulation, *entry(pc)*, did not show any significant pattern.

Table 2a. Equation (ii) Asymmetric regulation

	OLS estimates	t-statistic
Dependent Variable	entry	
intercept	-0.6412943	-0.74
legal	0.4984411	2.97
ideology	-0.1707091	-0.34
urbanpop	0.015199	0.95
subworker (lagged)	0.0058445	1.39
# Observations	37	
R-Squared	0.3965	

Table 2b. Equation (ii) Asymmetric regulation

	OLS estimates	t-statistic
Dependent Variable	entry	
intercept	-0.718073	-0.12
legal	0.5015454	3.04
subworker (lagged)	0.0085311	2.85
# Observations	37	
R-Squared	0.3793	

Table 2c. Equation (ii) Asymmetric regulation

	OLS estimates	t-statistic
Dependent Variable	entry	
intercept	-0.0558621	-0.09
legal	0.5419218	3.27
linesworker (lagged)	-0.0086778	2.61
# Observations	37	
R-Squared	0.3599	

Table 2d. Equation (ii) Asymmetric regulation

	OLS estimates	t-statistic
Dependent Variable	entry	
intercept		
procedures	-0.1394231	-2.60
linesworker (lagged)	0.0085237	2.24
# Observations	37	
R-Squared	0.3449	

Ideology, however, appears to have no impact on the decision to liberalize, as shown in Table 3. Telecommunications liberalization does not appear to be a partisan policy. However, this is not incompatible with some aspects of the reform process being partisan. For example, privatization of the incumbent could be a partisan policy, with right-wing parties being more inclined to privatize. But our composite indices do not single out individual policy dimensions, and hence we are not able to make any inference on them.

Table 3. Equation (ii) Asymmetric regulation

	OLS estimates	t-statistic
Dependent Variable	entry	
Intercept	-0.0503046	-0.08
Legal	0.542201	3.22
Ideology	-0.0680929	-0.14
linesworker (lagged)	0.0087813	2.54
# Observations	37	
R-Squared	0.3603	

As we saw in Table 1, our two indices of regulatory independence are not highly correlated with any of the other institutional indices, and in particular they are not correlated with overall regulatory quality. We interpret this as evidence that formal regulatory independence is compatible with different levels of general regulatory or institutional quality. However, this does not mean that regulatory independence does not show any systematic pattern. Our regression results on the determinants of independence (see Tables 4a-b) show that independence is a substitute for other ways to achieve commitment not to expropriate. In particular, the index of constraints on the executive appears to be negatively and significantly related to the creation of truly independent regulatory agencies. The sign of the ideological dummy and of the rule of law variable are also negative although not significant. This is consistent with the Levy and Spiller (1996) view of regulatory commitment and credibility. Countries achieve regulatory commitment not to expropriate investment, yielding good results in terms of industry performance, if they are able to create credible institutions that are well adapted to the institutional endowment of each country. Since institutional endowments vary across countries, the way different countries set up commitment institutions will vary. Take the cases of the UK and Chile, two countries that were among the first to successfully privatize their telecommunications incumbents and introduce competition. The UK, with its centralized system and majoritarian government, has very few constraints on the executive's

behaviour, so that new and special institutions, such as an independent regulator, must be put in place to achieve commitment.

Table 4a. Equation (ii) Regulatory independence

	OLS estimates	t-statistic
Dependent Variable	indep(pc)	
Intercept	0.5915471	1.11
ideology	-0.3931289	-1.18
staff	6.003888	2.65
rulelaw	-0.4127745	-1.52
instconst	-0.233859	-2.00
# Observations	37	
R-Squared	0.2547	

Table 4b. Equation (ii) Regulatory independence

	OLS estimates	t-statistic
Dependent Variable	indep(pc)	
Intercept	5.895357	4.52
ideology	-1.139659	-1.40
staff	15.28706	2.75
rulelaw	-1.0595	-1.59
instconst	-0.3805054	-1.33
# Observations	37	
R-Squared	0.2545	

In addition to this, the way the independent regulator is set up takes advantage of other features of the British institutional endowment, such as the respect for contracts and the independence of the judiciary. In Chile, however, with a presidential system and coalition governments, it is very difficult to change legislation, so that commitment is achieved through very detailed legislation, which, as thought at the time of reform, would make setting up a regulatory agency redundant and hence not cost-effective if there is any cost to independence (for example, in terms of political legitimacy or other costs to the political principals). Hence Chile is one of the few countries in our data set that does not even have a separate telecom regulator.

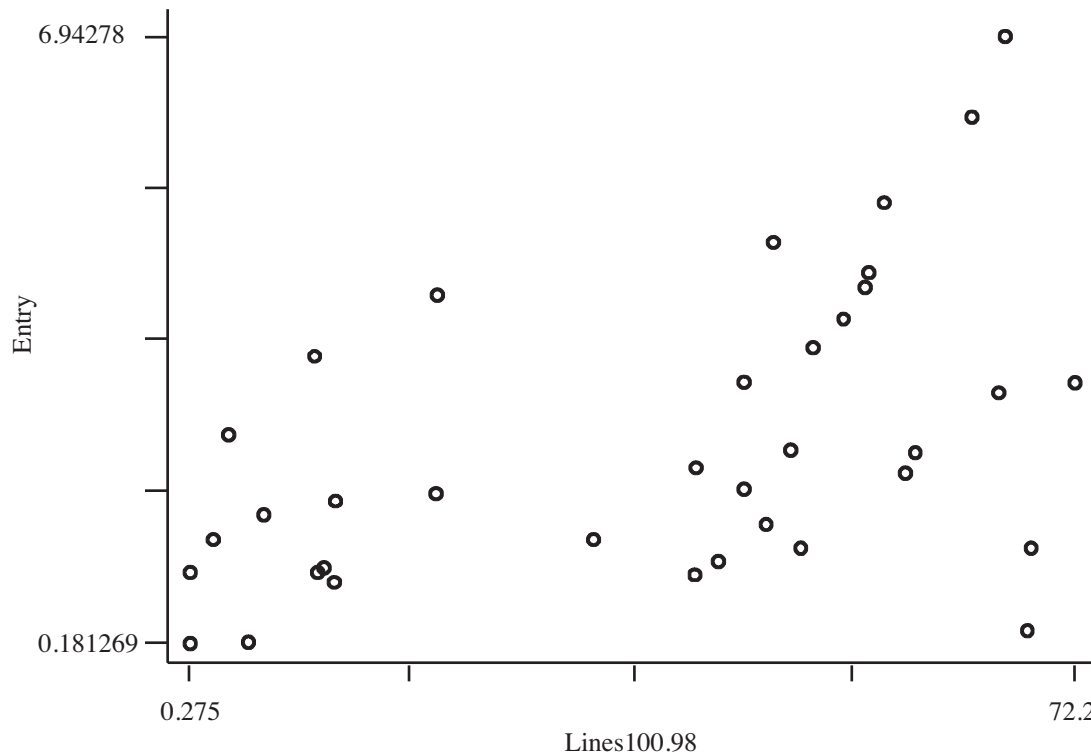
Quite robustly in our regressions, the effect of the size of the incumbent (as measured by the number of telecommunications staff some years before the reform) has a positive and statistically significant effect on the decision to create a truly independent regulatory agency. This is a surprising result, and we interpret it as the incumbent preferring an independent regulator in the face of the coming liberalization, which will inevitably be associated with more interest group competition. This is consistent with the view of Henisz and Zelner (2000) on the electricity industry, where they show that incumbents lobby for the creation of constraints on investment expropriation if they foresee strong interest group competition.

To sum up, the data do not reject the part of hypothesis 1 that predicts that market opening policies are related to the non-interventionist tradition of countries, nor the part of hypothesis 2 that predicts that regulator independence is determined by the institutional endowment of countries. We also find support for the part of hypothesis 2 that predicts that independence is associated with interest group pressure. In this case, we find that countries with a larger incumbent are more prone to create truly independent agencies. We conjecture that large incumbents may find that independent specialized regulators (with staff members probably recruited among previous incumbent staff) may be more easily captured than governments, and/or that large incumbents may have more to lose without an independent regulator, if the independent regulator, as a credible commitment device, contributes to alleviate the under-investment problem. This is so because larger incumbents have larger sunk investments in infrastructures.

4.2 The effects of policies

We first investigate the determinants of telecommunications network penetration (lines per 100 inhabitants and growth in lines per 100 inhabitants). These are the endogenous variables usually focused on in the studies that work with the ITU data set.

The following graph suggests the existence of a positive association between entry policies and telecom penetration:



In the regressions results, although the entry index is not significantly related to growth in network penetration, it is significantly related to network penetration in 2001 (see Tables 5a-b) if liberalization is taken as exogenous. This significant relationship disappears once the endogeneity of liberalization is taken into account.

Table 5a. Equation (i) Network penetration

	OLS estimates	t-statistic
Dependent Variable	linesinhab	
intercept	6.223462	2.37
gdpcap	0.001765	15.33
entry	2.173517	2.47
# Observations	37	
R-Squared	0.9012	

Table 5b. Equation (i) Network penetration

	IV estimates	t-statistic
Dependent Variable	linesinhab	
intercept	6.813583	1.63
gdpcap	0.001781	11.92
entry	1.824838	0.84
# Observations	37	
R-Squared	0.9002	

Instrumented: *entry* /Instrument: *legal*

The *entry* variable shows the same pattern in determining the telecom network penetration, as reported in Tables 6a-b, if we control for the effect of institutional variables such as regulatory quality. Hence OLS overestimates the contribution of the entry variable.

Table 6a. Equation (i) Network penetration

	OLS estimates	t-statistic
Dependent Variable	linesinhab	
intercept	5.893217	2.26
gdpcap	0.0016269	10.86
entry	1.725991	1.87
regqual	4.910904	1.41
# Observations	37	
R-Squared	0.9068	

Table 6b. Equation (i) Network penetration

	IV estimates	t-statistic
Dependent Variable	linesinhab	
intercept	6.993702	1.65
gdpcap	0.0016312	10.69
regqual	5.925041	1.26
entry	0.9316063	0.36
# Observations	37	
R-Squared	0.9042	

Instrumented: *entry* /Instrument: *legal*

The independence of the regulator does not appear to be a significant determinant of network penetration with OLS, but it becomes significant at the 10% level when we take into account the endogeneity of independence through Instrumental Variable estimation, as shown in Tables 7a-d.

Table 7a. Equation (i) Network penetration

	OLS estimates	t-statistic
Dependent Variable	linesinhab	
intercept	8.285623	2.13
gdpcap	0.0018636	16.00
indep	0.2909294	0.49
# Observations	37	
R-Squared	0.8843	

Table 7b. Equation (i) Network penetration

	OLS estimates	t-statistic
Dependent Variable	linesinhab	
intercept	9.937633	4.16
gdpcap	0.0018595	15.93
indep(pc)	0.8972316	0.541
# Observations	37	
R-Squared	0.8848	

Table 7c. Equation (i) Network penetration

	IV estimates	t-statistic
Dependent Variable	linesinhab	
intercept	-15.82578	-0.99
gdpcap	0.0017327	7.06
indep	5.169759	1.67
# Observations	37	
R-Squared	0.6096	

Instrumented: *indep*
Instruments: *staff*, *instconst*

Table 7d. Equation (i) Network penetration

	IV estimates	t-statistic
Dependent Variable	linesinhab	
intercept	10.61103	3.17
gdpcap	0.0018608	11.01
indep(pc)	8.359294	1.72
# Observations	37	
R-Squared	0.7820	

Instrumented: *indep(pc)*
Instruments: *staff*, *instconst*

Next, we look at the determinants of productivity in the telecommunications sector, as measured by subscribers per employee and lines per employee. The principal components index of asymmetric deregulation has a negative impact on productivity (measured as subscribers per employee) in levels, although the significance of this estimate declines as we add variables. The same happens when productivity is measured as lines per employee, although the regression results are not reported here.

Table 8. Equation (i) Productivity

	OLS estimates	t-statistic
Dependent Variable	subworker	
intercept	311.5764	4.72
gdpcap	0.0014085	0.33
entry(pc)	-80.46346	-2.05
regqual	133.5519	1.39
# Observations	37	
R-Squared	0.1862	

We checked for the effect of the ad hoc entry index on productivity, first with OLS and next with IV estimation using the legal index as instrumental variable, without any significant results.

Finally, we see in Tables 9a-d that regulatory independence has a negative or non-significant (when appropriately instrumented) effect on productivity.

To sum up this part of the empirical analysis, we find weak support for the part of hypothesis 3 that predicts that independence contributes to alleviate the under-investment problem.

Table 9a. Equation (i) Productivity

	OLS estimates	t-statistic
Dependent Variable	linesworker	
intercept	218.8331	4.69
gdpcap	0.0026235	1.85
indep	-13.5829	-2.00
entry	7.860585	0.72
# Observations	37	
R-Squared	0.2087	

Table 9b. Equation (i) Productivity

	OLS estimates	t-statistic
Dependent Variable	subworker	
intercept	472.6807	4.28
gdpcap	0.0050013	1.49
indep	-24.21684	-1.51
entry	4.929714	0.19
# Observations	37	
R-Squared	0.1238	

Table 9c. Equation (i) Productivity

	IV estimates	t-statistic
Dependent Variable	linesworker	
intercept	342.9504	2.23
gdpcap	0.005167	2.19
indep	-21.675	-0.75
entry	-42.40925	-1.25
# Observations	37	
R-Squared		

Instrumented: *entry, indep*
 Instruments: *legal, staff*

Table 9d. Equation (i) Productivity

	IV estimates	t-statistic
Dependent Variable	subworker	
intercept	774.7448	2.25
gdpcap	0.010074	1.90
indep	-52.31917	-0.80
entry	-90.9437	-1.19
# Observations	37	
R-Squared		

Instrumented: *entry, indep*
 Instruments: *legal, staff*

5. Conclusions

In this paper, we presented new data, in the form of four indices, on entry policies and the independence of regulators for a cross-section of countries. These indices take into account the multi-dimensionality of policies and institutions. In the case of independence, this moves the empirical literature on regulation one step closer to the empirical literature on Central Bank independence in monetary policy, where the use of independence indices as opposed to *dummy* variables has become common practice.

These indices were combined with a comprehensive set of performance, institutional and political data to quantify both the determinants and the impact of telecommunications policies. We found that liberalization policies which favour entrants are negatively associated with the degree to which countries have an interventionist tradition, but not with the partisan ideology of reforming countries *per se*. We also found that countries where the institutional endowment constrains less the behaviour of the executive bodies, and countries with a stronger incumbent, are more prone to create truly independent regulatory agencies. The effect of the institutional endowment is consistent with the previous literature on regulatory institutions. The positive association between incumbent size and independent regulators has not been observed before and may seem puzzling. We conjecture that large incumbents may find that independent specialized regulators (with staff members probably recruited among previous incumbent staff) may be more easily captured than governments, and/or that large incumbents may have more to lose without an independent regulator, if the independent regulator (as a commitment device) contributes to alleviate the under-investment problem. This is so because larger incumbents have larger sunk investments in infrastructures.

We found weak evidence that the creation of truly independent regulatory agencies has a positive effect on network penetration when we take into account the endogeneity of independence. There is no evidence, with this preliminary data set, of a significant effect (positive or negative) of market opening policies on any of the performance variables used in this study. However, a positive significant effect on network penetration would be predicted with the same data set if the endogeneity of market opening policies was not taken into account. This illustrates (along the lines of Röller and Duso, 2002, and Besley and Case, 2000) that very different results may be (incorrectly) obtained if the endogeneity of policies is not taken into account.

Despite the importance of creating politically sustainable regulatory systems, the establishment of separate regulatory agencies in telecommunications is a very recent phenomenon.

Equivalently, it is probably too early to reach any final conclusion on the effects of different market opening policies. Our results on the determinants of policies and institutions, however, point to some systematic relationships that fit well with some of the theoretical literature on institutions. Further research may also explore in a more systematic way the interaction between market opening policies and institutional design.

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Appendix 1

TELECOMMUNICATIONS POLICIES:
DETERMINANTS AND IMPACT**Original policy variables. Definition and measurement (1)**

Investment conditions imposed on entrants: equals 0 if entry to the industry is subject to investment conditions of any kind and 1 otherwise. If there are no entrants, the value is set to 0.

Average Number of Mobile Providers: average of the number of providers that were in operation in 1996 and 1997.

Number Portability. Fixed Telephony: equals 0 if number portability in fixed telephony is not possible and 1 otherwise.

Carrier Selection. Local: equals 0 if carrier selection of the local operator is not possible and 1 otherwise.

Carrier Selection. Long Distance and International: equals 0 if carrier selection of the long distance operator (national & international) is not possible and 1 otherwise.

Carrier pre-selection. Local: equals 0 if carrier pre-selection of the local operator is not possible and 1 otherwise.

Carrier pre-selection. Long distance and international: equals 0 if carrier pre-selection of the long-distance operator (national & international) is not possible and 1 otherwise.

Year of establishment of effective operation: equals 0 if the regulatory authority is a department of the government and grows from 1 to 64 as the year of establishment goes back in time.

Private Ownership of the incumbent (%): percentage of the incumbent that is not owned directly by the government.

Local Loop Unbundling Availability: equals 0 if local loop unbundling is not available and 1 otherwise.

Wireless Local Access licensing: equals 0 if there are no licences for Wireless Local Access and 1 otherwise.

Cable restrictions imposed on incumbents: equals 0 if incumbents have no restrictions to cable ownership and 1 otherwise.

Method of Spectrum Allocation: equals 0 if the mobile industry is under monopoly, 1 if the licensing process is on a “first come first served” basis, 2 if the spectrum allocation is done through comparative tenders, 3 if it is done through competitive tenders with a financial offer, and 4 if it is done through auctions.

(1) Unless otherwise stated, the measurement refers to the situation at the beginning of 1998. The original data on which the indices are based is available upon request.

Appendix 1 (continued)

Licensing: equals 1 if the regulator has the power to grant licences and 0 if it is a function carried out only by a ministry. If the ministry is the only regulator, this variable is set to 0 as well.

Interconnection: equals 1 if the regulator has the power to establish and administer interconnection regimes and 0 in the same situations as in the previous variable.

Tariffs: equals 1 if the regulator can determine regulated tariffs and 0 in the same situations as in the previous variable.

Scarce Resources: equals 1 if the regulator can administer scarce resources, such as spectrum frequencies and numeration plans, and 0 in the same situations as before.

Universal Service: equals 1 if the regulator can establish and administer a universal service and 0 in the same situations as before.

Funding: equals 0 if the regulator gets its funds from the government budget, 1 if it also gets fees from the operators, and 2 if the funding is only through fees paid by the operators.

Appointed by: equals 0 if the head of the regulatory authority is appointed directly by the government, 1 if he/she is appointed by the government and the legislature, and 2 if he/she is appointed only by the legislature. If the regulatory authority is a department of the government, it takes the value of 0.

Length of term: years of the term in office of the regulator. If the regulatory authority is a department of the government or its term is not defined, the value is set to 0.

Reporting to: equals 0 if the regulatory authority has to report to the government, 1 if it has to report to the government and to the legislature, 2 if it has to report only to the legislature and 3 if it reports to no one.

Appendix 2

TELECOMMUNICATIONS POLICIES:
DETERMINANTS AND IMPACT**Indices Construction****A2.1. *Entry* and *indep***

The indices *entry* and *indep* each use a number of original variables in the following way. First, the original variables are re-coded, so that each of the observations can be measured on a 0-1 range. This is done by dividing the original metric for each observation by the maximum value of the variable (for example, if Spain has a value of 2 in “method of spectrum allocation”, the re-coded value will be $2/4=0.5$, where 4 is the maximum value that this original variable can take). Then the values of all the re-coded original variables used for the index are added for each country. Hence the final index will have a maximum value equal to the number of original variables used in its computation.

Entry uses as original variables: Investment conditions imposed on entrants, Average number of mobile providers, Method of spectrum allocation, Number portability (fixed telephony), Number portability (mobile telephony), Carrier selection (local), Carrier selection (long distance and international), Carrier pre-selection (local), Carrier pre-selection (long distance and international).

Indep uses as original variables: Licensing (excl. Mobile), Interconnection, Tariffs, Scarce resources, Universal service, Funding, Appointed by, Term, Reporting to, Year of establishment of effective operation, Private ownership of incumbent.

Indep(pc) and entry(pc)

These indices are computed using the principal components methodology. The original variables for each index are used to find the linear combinations that minimize the overall variance.

Indep(pc) uses as original variables: Licensing, Interconnection, Tariffs, Scarce resources, Universal service, Funding, Appointed by, Length of term, Reporting to. Out of the three principal components selected, we selected number 1 for ease of interpretation.

Entry(pc) uses as original variables: Investment conditions imposed on entrants, Average number of mobile providers, Number portability (fixed telephony), Carrier selection (local), Carrier selection (long distance & international), Carrier pre-selection (local), Carrier pre-selection (long distance & international), Year of establishment of effective operation (1), Public ownership of the incumbent, Local loop unbundling availability, Wireless local access licensing, Cable restrictions imposed on incumbents. Out of four principal components obtained, we selected number 2 for ease of interpretation.

(1) “Year of establishment of effective operation” is used here for the principal components entry index, suggesting that perhaps it may indicate the year in which the liberalization process starts. Both this original variable and “Public ownership of the incumbent” may be related both to independence and to entry, which is why we have them in the *entry(pc)* index and in the *indep* index. Their loading in the final *entry(pc)* index chosen, however, is either negative or negligible.

Appendix 2 (continued)

Principal components indices are obtained in both cases as follows: We describe the total variance of a set of n points (the original variables) in p dimensional space by introducing a new set of p orthogonal and uncorrelated variates (the new indices). The new set is formed by taking normalized linear combinations of the original set so that the r th variate generated has the r th largest variance.

The following tables show the numerical results for the computation of Principal Components, first for the set of “independence” variables, and second for the set of “asymmetric deregulation” variables. The figures in the interior cells are the loadings of each original variable in each of the new components.

Table A2.I

	Component		
	1	2	3
Licensing	0.227	0.656	0.481
Interconnection	0.842	0.232	0.202
Tariffs	0.741	0.414	
Scarce resources			0.915
Universal service	0.351	0.181	0.705
Funding	0.732	0.257	0.266
Appointed by	0.128	0.744	
Length of term	0.643	0.142	0.139
Reporting to		0.684	

Appendix 2 (continued)

Table A2.II

	Component			
	1	2	3	4
Investment conditions imposed on entrants	-0.202	-0.504	0.154	-0.686
Average number of mobile providers	0.330	0.220	0.704	0.131
Number portability (fixed telephony)	-0.315	0.824		0.115
Carrier selection (local)	0.765		0.192	0.165
Carrier selection (long distance & international)	0.135	0.196	0.743	0.390
Carrier pre-selection (local)	0.906	0.262	0.136	
Carrier pre-selection (long distance & international)	0.373	0.709	0.203	
Year of establishment of effective operation	-0.793	-0.225	-0.347	
Public ownership of the incumbent	-0.166		-0.859	
Local loop unbundling availability	0.441	0.715		0.143
Wireless local access licensing	0.270	0.562	0.349	-0.352
Cable restrictions imposed on incumbents			0.388	0.804

Appendix 3

TELECOMMUNICATIONS POLICIES:
DETERMINANTS AND IMPACT**Values for the indices on liberalization and regulator independence**

	indep	indep(pc)	entry	entry(pc)
Germany	7,67095	0,19029	5,09184	3,03192
Chile	1	-2,01649	4,059	0,15638
France	4,20381	-0,66522	2,07237	-0,48506
USA	9,38095	0,0352	6,94278	0,853
Spain	5,84762	0,59838	2,13408	-0,59481
Italy	5,85	0,3653	1,89987	-0,92657
Japan	0,35	-2,01649	3,79233	-0,42421
N. Zealand	1	-2,01649	4,64653	-0,98545
UK	6,51429	1,311	4,31309	1,56787
Sweden	6,25714	0,93042	3,08131	-0,41989
Peru	4,40476	0,70353	1,60863	-0,67873
Argentina	4,24762	-0,7008	1,84994	-0,59886
Canada	9,31429	0,72516	6,04781	1,30539
Mexico	3,75143	0,27196	3,37677	0,74609
Venezuela	7,5381	0,19817	1,02202	-0,45261
Brazil	7,84762	0,62186	1,76561	-0,03961
India	0,5619	-1,5399	1,33618	0,19229
Philippines	7,4381	-0,2334	2,5	-0,05405
Singapore	7,08143	0,62973	3,08843	-0,15796
Israel	0,46	-2,01649	1,50674	0,09664
Jordan	7,8381	0,27204	0,97128	-0,48573
Morocco	3,78095	0,24166	0,19388	-0,32733
Ethiopia	5,57088	-0,59084	0,18127	-0,24681
Madagascar	6,62776	0,62199	0,97473	-0,45348
South Africa	7,31429	-0,39637	0,85994	-0,44678
Bulgaria	5,06667	1,62873	1,33426	-0,24087
Finland	4,4501	0,23449	4,14624	3,63491
Denmark	8,0381	0,71002	2,97274	-1,1273
Norway	6,30476	0,81038	2,96901	-0,96191
Portugal	7,77857	0,47087	0,94137	-0,54706
Switzerland	5,47143	-0,52012	1,23732	-0,05314
Australia	4,17762	-1,72753	3,47705	0,46473
Austria	5,51429	0,87485	2,33373	0,03961
Belgium	5,68048	0,41756	1,23472	-0,49076
Ireland	7,33333	-0,37116	1,08901	-0,42951
Luxembourg	3,5619	0,97623	0,32099	-0,48045
Netherlands	6,26676	0,9715	2,30331	0,09933