

# Telecommunications Performance, Reforms, and Governance\*

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## Abstract

This paper assesses the effects of private capital and independent regulatory agencies on telecommunications performance by using cross-country panel data from 1990 to 2003. In general, we find that having independent regulatory agencies positively affects affordability and labor productivity, but negatively affects quality; while having private capital positively affects access, quality and labor productivity, but negatively affects affordability. However, reform policies affect developing and developed countries differently in some cases. We also find that governance plays an important role as it affects performance and interacts with reform policies.

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# 1. INTRODUCTION

The economic literature on telecommunications reform is one of the largest on infrastructure reform (certainly larger than sanitation and any transport service and arguably in close competition with energy). This results partially from the relatively good quality of economic data on telecoms.<sup>1</sup> But the academic popularity of the sector also stems from three of its characteristics. First, telecoms' impressive rate of technological change seems to have broken more bureaucratic impediments to change than reformers could have ever hoped for. Thus, it is important to get a sense of how much pro-active reforms added to the gains offered by the technological trend. Second, in spite of the high potential for competition in the sector, its complex regulatory dimensions seem to drive the size and distribution of the rent generated by the technological revolution. Third, the relative importance of the increased role of private operators in service delivery continues to be a source of argument.

The drivers of the impact of reforms and their distribution have been quite well documented in a plethora of country specific studies (with a very significant share on the US and the UK).<sup>2</sup> The impact of reforms has also been tested in cross-country studies but these are significantly scarcer than country specific ones. We review some relevant cross-country studies later in some detail. Their country coverage varies from as little as 12 countries as in Fink et al. (2001), with a focus on Asian countries, to 200 countries as in Wallsten (2003), with both developed and developing countries. We do a cross-country analysis on the impact of reforms on telecom performance by using a database of 204 countries, 153 developing and 51 developed. The sample size is thus the largest so far—although only marginally so when compared to Wallsten's.

When drawing general lessons for reformers, the main advantages of a large sample are that it reduces the risk of sample selection bias and allows a quick diagnosis of the differences in the impact of reforms across country types—e.g. developed vs. developing. Its main disadvantage is that it limits the policy assessment to fairly broad categorizations of reforms in order to ensure cross-country compatibility. In this paper, we focus on the following two broad categorizations of reforms: (i) the commitment to open the sector to private operators as a proxy for the commitment to open the sector to competition; (ii) the commitment to ensure a fair and efficient regulation of the residual monopoly elements in the sector. We test for the impact of these two reform policies on access, prices, quality and labor productivity in both developed and developing countries.

This paper adds to earlier work by increasing significantly the coverage of time elapsed since the start of the reforms. While our sample starts only in 1990, it ends in 2003; which is 4 to 6 years more than most of the previous studies.<sup>3</sup> This is significant since major reforms actually took place during the latter part of the 1990s in many countries and hence most of the earlier studies only covered a couple of years since the

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<sup>1</sup> This quality and availability owes a lot to the efforts of the International Telecommunications Union.

<sup>2</sup> For a recent survey, see for instance, Ai and Sappington (2004).

<sup>3</sup> In past studies, the period coverage started at the earliest in 1980 (Gutiérrez, 2003) and ended in 2001 at the latest (Li and Xu, 2004).

reform.<sup>4</sup> Another contribution of the paper is the modeling of the effects of corruption in the sector and their interactions with reform policies. These interactions add useful policy results to Wallsten's inclusion of a governance variable as a driver of performance.<sup>5</sup> Finally, we also look into the relevance of investment risk and its interactions with reform policies for telecom performance.

The paper is organized as follows. Section 2 offers background on the state of reforms in the sector. Section 3 discusses the performance indicators available and presents basic statistics. Section 4 summarizes previous cross-country academic literature on the impact of telecom reforms. Section 5 presents the econometric analysis resulting from this larger database on telecom performance. Section 6 concludes.

## 2. THE MAIN “MACRO” REFORMS IN TELECOM

The reforms of the 1990s brought major changes to the traditional structure of the telecommunications sector. Until then, the typical operator was a monopolistic state-owned company. In most countries, this monopoly was self-regulated or regulated by the government rather than by an independent agency. The main drivers of regulation tended to be fiscal or employment concerns instead of service oriented concerns. Indeed, prices were often intended to generate fiscal revenue rather than to reflect costs and complex cross-subsidy schemes.

This situation changed with the major technological shocks of the 1990s. Besides the unbundling of the sector stimulated by the technological revolution, the first common element of reforms across countries may be the opening to competition. In most countries, this materialized by an increased role of the private capital in the sector. Indeed, state-owned operators were usually separated in multiple companies and in most cases they were sold, given in concession or licensed to private operators or investors which in turn started to compete with the incumbents and other entrants. Because there is no reliable measure of the degree of competition for a large sample of countries, the existence of private capital investment in telecoms may be the best proxy to document the commitment of the government to increase competition in the sector. It relies on the minimum volume of information and yet it gives a reasonable sense of the commitment to competition for the largest possible sample of countries. It is clearly not perfect since the opening to the private sector is necessary but not sufficient to increase competition. However, the experience suggests that the existence of private capital and the existence of competition are highly correlated when both are measured correctly.<sup>6</sup>

According to the data from the International Telecommunications Union (ITU) on whether a country has at least some private ownership in their telephone companies, the

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<sup>4</sup> As shown later in a summary table, on average, developing countries introduced their major reforms around 1998 while developed countries did it around 1997.

<sup>5</sup> See Wallsten (1999).

<sup>6</sup> Note that the data on competition actually raises more issues. Besides the coverage problem; international databases on the existence of competition often refer to the “legal” status but not to the “de facto” situation.

share of countries with private capital in main fixed lines operators increased from 9% to 53% in developing countries and from 17% to 82% in developed countries between 1990 and 2003. This information is summarized in table 1.<sup>7</sup>

**Table 1: Evolution of reform implementation from 1990 to 2003**

	% of sample by country group		Number of Observations		
	Developing	Developed	Developing	Developed	Total
<b>Privatization/competition</b>					
Number of Countries with Private Capital as of 1990	9%	17%	129	35	164
Number of Countries with Private Capital as of 2003	53%	82%	129	34	163
Average Year of Privatization*	1997	1997	57	23	80
<b>Regulation</b>					
Number of Countries with IRA as of 1990	5%	12%	153	51	204
Number of Countries with IRA as of 2003	65%	57%	153	51	204
Average Year of Establishment of IRA*	1998	1997	93	23	116

Source: Own calculations using ITU data. \* Average among countries that reformed between 1991 and 2003.

The regulatory environment has also changed significantly but tracking changes in regulatory systems is much more complex than tracking the extent of private sector participation. One of the most directly observable policies aimed to change regulatory systems may be establishment of an independent regulatory agency (IRA) for telecommunications. This could be the strongest public signal of the commitment to end self-regulation and to replace political considerations by economic concerns in regulation design.<sup>8</sup> The creation of IRAs is a process being monitored and documented by ITU as well. ITU considers that an agency is independent if it is separate from the ministry and from the incumbent in its structure, financing, and decision-making process.

This choice to proxy for the commitment to reform the regulation allows for a simple classification of countries into those that have an IRA and those that do not. ITU reports a list of countries that have an IRA. After consulting with ITU experts, we assume that countries that do not appear in ITU's list do not have an IRA. This assumption is not as strong as it may seem. Countries have incentives to report the creation of IRAs since these agencies play an important role in the interconnection process (one of the most critical regulatory issues for the sector) as well as in other pricing related matters.<sup>9</sup> Table 1 shows that the share of countries with an IRA increased from 5% to 65% in developed countries and from 12% to 57% in developing countries.

Finally, a comparison of the information on private capital and IRAs provides useful additional insights. First, it shows that among developing countries there are more

<sup>7</sup> See Estache and Goicoechea (2005a) for a more detailed discussion of the data.

<sup>8</sup> The concept of independence is to a large degree subjective. Estache et. al. (2002) define independence as having financial autonomy (because if the minister influences the budget to cover the regulator's expenses there is a potential conflict of interests). But independence might also be considered in terms of capacity to make decisions. Also there is some subjectivity in the data generation process. Wallsten (2003) states that regulators might have incentives to report they are independent when they are not de facto independent. He also makes the argument that no matter what definition of independence is used; regulatory agencies will always be to some degree connected to the government.

<sup>9</sup> Interconnection is defined, in the Telecommunications regulation handbook (2004), as connecting two networks owned by different companies in a way that ensures the proper functioning of the two systems.

countries with IRAs than countries with private involvement in the local loop in 2003 while the opposite is true for developed countries. In other words, a country does not seem to need a regulator to attract private operators and a regulator does not guarantee that the government will be open to the private sector in its local loop. Second, it shows that, while on average the introduction of the private sector was simultaneous in developed countries (in 1997), private sector participation briefly preceded the creation of regulatory agencies in developing countries.

### 3. TELECOM PERFORMANCE AND ITS DIMENSIONS

In this section, we first discuss the dimensions of telecom performance of interest to policymakers. Then we define the performance indicators we have selected in order to analyze the impact of reform policies on sector performance and present basic data for developing and developed countries.

It could be argued that the five main dimensions of telecom performance of interest to policymakers are fiscal costs, access rates, affordability of services, quality of services, and productivity. The main challenge is thus to identify economic indicators that best approximate these dimensions in practice and for which data are available for a large sample. The need for wide coverage essentially rules out the fiscal dimension of the analysis. There is essentially no statistical information on the level of subsidies in the sector before and after reforms. While in many countries, in particular the richest ones, it could be argued that reforms have simply ended any type of public financing in the sector, for many of the poorest, this assumption does not necessarily hold. In the poorest parts of Central America or Sub-Saharan Africa for instance, subsidies are still key sources of financing for connectivity in rural or remote areas.

Access indicators should measure the extent to which people have the right to obtain or take advantage of telecom services—it does not necessarily mean they use the service. Affordability indicators should give a sense of the extent to which telecom services are provided at a reasonable price. Quality indicators should encompass both qualitative and quantitative measures of quality. The former captures perceived quality or customer satisfaction, while the latter captures technical quality reported by the operators with a low degree of discretion involved. Finally, productivity indicators should provide a measure of the improvements on the production side of the business.<sup>10</sup>

With this in mind, we have selected six indicators from the ITU. The proxy for access is the number of telephone subscribers defined as “total telephone (fixed mainlines plus cellular) subscribers per 1000 inhabitants.” This variable or one of its variations has been used in almost all previous papers. We use telephone subscribers, as opposed to mainlines, in order to have a better representation of the current telephone market in which mainlines and mobiles are substitutes. Even though this may be the best access indicator available, it is far from perfect. As Wallsten (1999) explains, it is not possible to

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<sup>10</sup> See Estache and Goicoechea (2005b) for more details on performance dimensions.

differentiate if one person has multiple lines, or if one line is used by multiple persons. Thus, using the number of subscribers may over or understate access.

Basic data are reported in table 2. As expected there are pronounced differences in the access rate between developed and developing countries, with the former displaying an average access rate approximately 6 times the latter's. Theoretically, reform policies, such as introducing private capital and establishing an IRA, are expected to increase access rates.

**Table 2: Average performance 1990-2003**

	Means		Number of Observations		
	Developing	Developed	Developing	Developed	Total
Telephone Subscribers per 1000 people	123 (171)	709 (363)	2073	647	2720
Price of Local Phone Call (US cents/10,000 GDPpc)	169 (466)	6 (6)	1570	446	2016
Annual Residential Subscription Fee (US\$/10,000 GDPpc)	958 (1891)	76 (38)	1650	461	2111
Annual Business Subscription Fee (US\$/10,000 GDPpc)	1387 (2632)	101 (60)	1623	453	2076
Phone Faults (reported faults/100 mainlines)	73 (96)	19 (17)	1094	328	1422
Telephone Mainlines per Employee	68 (57)	175 (111)	1787	600	2387

Source: Own calculations using ITU data. Standard deviations in parenthesis.  
Countries were classified in developing and developed according to their 2001 GNI per capita.

Regarding affordability, the only information available for a large set of countries is the average price and occasionally, the tariff structure. The information is however widely seen as not reliable since it does not account for many of the “informal” alternatives available to phone users—e.g. calling cards. This may be why only three of the previous cross-country studies have tried to document the impact of reforms on prices. We use the price of a 3-minute local phone call in US cents and the monthly subscription fee (for residents and for business) in US dollars as our proxies for affordability. An issue with these indicators is that they do not take into account prices in the mobile segment, thus, we are using proxies for affordability only in the fixed line market. However, these are the best data available at the moment.

The specific definitions offered by ITU for the selected affordability variables are as follows: The price of a local call refers to the cost of a peak rate 3-minute fixed line call within the same exchange area using the subscriber's own terminal (i.e. not from a public telephone). The monthly residential (business) phone subscription fee refers to the recurring fixed charge for a residential (business) subscriber for using the public switched telephone network. The charge should cover the rental of the line but not the rental of the terminal (e.g. telephone set) where the terminal equipment market is liberalized. In some cases, the rental charge includes an allowance for free or reduced rate call units. If there are different charges for different exchange areas, the largest urban area is used.

Table 2 shows that a local phone call normalized to GDP per capita was about 30 times higher in developing countries than in developed ones, while the annual cost of a

residential or business line (normalized in the same way) was about 14 times larger in developing countries than in developed countries.

Even though the service is expected to become somewhat more affordable after the implementation of reforms, the elimination of cross-subsidies after the incumbent is privatized and the tariff rebalancing that often takes place may both increase the price of some services, including some of the residential services. Also, some characteristics of the reform process, such as the existence of exclusivity periods may influence the price upward. It is thus difficult to theoretically define the expected sign of the impact of reform policies on these indicators and hence on affordability.

Data on quality enjoys a much more limited coverage. There are some indicators on the quality perception of telephone services, but these are only available for two or three years at most. Thus, we rely on technical quality data reported by the telephone companies, which is available for a longer period of time. Specifically, we selected the number of reported telephone faults per 100 mainlines as a proxy for the quality of telephone services. The indicator is formally calculated by dividing the total number of reported faults during the year by the total number of mainlines in operation and multiplying by 100. It is important to note that the definition of faults might vary. Some countries include faulty customer equipment. Others distinguish between reported and actual faults found. There is also sometimes a distinction between residential and business lines. Another consideration is the time period as some countries report this indicator on a monthly basis; in these cases data are converted to yearly estimates. As measured here, quality seems to be remarkably worse in developing countries, with an average failure rate of 73%, compared to 19% in developed countries.

Our proxy for quality might be misleading in two ways. First, reporting faults might depend on the rules, regulations and dynamic of the sector in the country. Second, after reforms are implemented, companies may simply improve their reporting systems which may result in a larger number of the faults being measured. It is thus impossible to predict ex-ante the correlation between reform policies and reported faults because the improvements in reporting and measurement from regulatory reform may actually lead to a negative correlation. The net correlation is then the result of an actual performance change and a measurement change.

Finally, productivity is approximated by labor productivity simply because there is not enough data on capital and other inputs to get a better grasp of total factor productivity of the sector for a large enough number of countries and for a long period of time. Labor productivity data are also generated from the ITU database and approximated by the number of telephone mainlines per employee. This indicator is calculated by dividing the number of mainlines by the number of staff (with part-time staff converted to full-time equivalents) employed by telecommunications operators. Basic data reported in table 2 show that labor productivity is (on average) 2.5 times higher in developed than in developing countries. However, for both country groups, the expected correlation between productivity and reform policies is positive.

To provide a visual sense of performance at different scenarios of reform policies, we provide in table 3 a basic statistical summary that compares countries that have committed to reforms to those that have not as of 2003. We report the means, and below in parenthesis, we include the associated standard deviations and the number of

observations for each group. We report averages of performance outputs for developing and developed countries, as well as for the whole sample. Countries are also grouped according to their commitment to reforms. In the first column, we include countries that have not reformed, in the sense that they neither have an IRA, nor any private ownership. The second column reports averages for those countries that have an IRA, but in which firms are state-owned. The third column presents countries with private capital but without a regulator. Together, columns 2 and 3 refer to those countries that have implemented some reform policies. In the fourth column, we include those countries that have committed the most to reforms, as they have both an IRA and at least some private capital.

The big picture that emerges from this very basic data analysis seems to confirm some of the expectations about reforms but it also hints at some unexpected correlations. In general, countries with private capital and independent regulators have better performance indicators.<sup>11</sup> In other words, the basic data analysis tells us that countries with private capital and an IRA have, on average, more subscribers, lower price of local call, lower fixed costs, lower faults, and higher labor productivity. In section 5 we will present an econometric analysis intended to validate or nuance the conclusions derived from this very basic data analysis.

Additionally, this basic analysis reveals significant differences on the correlation between performance and reform policies between developed and developing countries. Regarding access, the gap between reformers and non-reformer is bigger in developed countries than in developing ones. This somewhat naïve look at the data suggests that in terms of access developed countries have managed to get more from reforms than developing countries. It already hints at the need to look into the relevance of other factors such as governance, which may work differently in developed and developing countries.

Regarding affordability and quality, developing countries that have committed to reforms in some way (by allowing the presence of private capital, establishing an independent regulator, or both) enjoy better performance than developing countries without these reforms. An exception is observed in the price of a local call, where establishing a regulator is correlated with an increase the price. These conclusions do not hold for developed countries mainly because most of them have committed to reforms, and therefore some samples are too small to draw any conclusions. Keeping this in mind, we observe in table 3 that reforms in developed countries seem to buy lower business subscription fees, and that the presence of private capital improves labor productivity (while having an independent regulator is on average correlated with lower productivity). However, some developed countries that have not reformed seem to be doing better than the reformers. Examples are found in the price of a local call and the number of phone faults.

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<sup>11</sup> It is important to keep in mind that this is a statement about correlation, not about causality. This positive correlation may reflect a number of things (for example selection bias, as it might be the case that reformers do everything better than non-reformers). This initial assessment needs to be validated by the econometric work discussed later.



**Table 3: Performance vs. reform in 2003 – Averages for different country groups**

	Mean (standard deviation, number of observations)				
	(1)	(2)	(3)	(4)	(5)
	Without IRA Without PRIV	With IRA Without PRIV	Without IRA With PRIV	With IRA With PRIV	All countries
<b>Telephone Subscribers/ 1000 people in...</b>					
Developing	181 (158,16)	191 (214,30)	226 (205,10)	412 (367,46)	290 (300,115)
Developed	960 (272,2)	1049 (378,2)	1171 (254,5)	1360 (175,20)	1277 (276,36)
All countries	268 (300,18)	245 (303,32)	541 (508,15)	700 (543,66)	526 (514,151)
<b>Price of Local Phone Call in...</b>					
Developing	87 (138,9)	95 (147,21)	58 (68,4)	60 (97,37)	75 (114,84)
Developed	0 (na,1)	6 (na,1)	0.9 (1,2)	6 (3,12)	5 (5,20)
All countries	78 (133,10)	91 (145,22)	39 (60,6)	47 (87,49)	62 (106,104)
<b>Annual Residential Subscription Fee in...</b>					
Developing	630 (577,10)	464 (364,19)	253 (212,3)	392 (410,38)	499 (533,84)
Developed	57 (na,1)	99 (na,1)	91 (65,2)	83 (32,14)	79 (32,22)
All countries	578 (574,11)	446 (363,20)	188 (177,5)	309 (376,52)	412 (504,106)
<b>Annual Business Subscription Fee in...</b>					
Developing	830 (706,10)	650 (533,19)	438 (310,3)	629 (633,37)	759 (726,83)
Developed	132 (na,1)	99 (na,1)	134 (95,2)	94 (32,12)	97 (41,20)
All countries	767 (703,11)	623 (534,20)	316 (279,5)	498 (596,49)	630 (702,103)
<b>Phone Faults in...</b>					
Developing	64 (47,6)	26 (32,10)	53 (na,1)	27 (25,16)	38 (39,39)
Developed	4 (na,1)	..	23 (na,1)	21 (30,9)	17 (23,16)
All countries	55 (49,7)	26 (32,10)	38 (21,2)	24 (26,25)	32 (36,55)
<b>Mainlines per Employee in...</b>					
Developing	66 (31,10)	107 (87,9)	110 (66,3)	108 (63,16)	98 (70,43)
Developed	..	146 (43,2)	441 (120,2)	192 (50,10)	215 (96,19)
All countries	66 (31,10)	114 (80,11)	242 (197,5)	141 (71,26)	134 (95,62)

Source: Own calculations using ITU data. Countries were classified in developing and developed according to their 2001 GNI per capita.

- Coverage for 2003 is not as good as the one for previous years. Thus, for some groups samples are too small to draw significant conclusions.

- na means not applicable. Used when there is only one observation in the group, which makes impossible to calculate the standard deviation.

- IRA refers to independent regulatory agency, and priv refers to the existence of private capital.

- The price of a 3-min local call is expressed in 2000 US cents/10,000 GDPpc; while annual subscription fees are expressed in 2000 US dollars/10,000 GDP pc.

- Phone faults correspond to reported faults per 100 mainlines.

## 4. THE EVIDENCE ON THE IMPACT OF TELECOM REFORMS

The two main reform policies covered in this paper have already been at the center of most of the cross-country analyses of telecom performance. Before presenting the new results derived from more recent observations, it may be useful to cover in some detail the main lessons from the existing literature.

The first consideration that comes to mind is that, simply because the time elapsed since the reforms has been rather short, most of these earlier results can often be viewed as a first cut at early stages of reform or as the short-term impact of reform. The

design of the studies is somewhat diverse and often reflects the authors' preferences in terms of the trade-off between coverage and specificity of the characteristics of reform policies. Some authors have chosen to use variables about the existence (or implementation) of reform policies with large samples, while others have used variables that capture details or specific characteristics of policies (in terms of degree, procedures, and/or sequence) with smaller samples. The main concern of authors preferring more detailed modeling of reforms is that the use of dummy variables on the existence of reforms may not capture the diversity of reforms. For example, a dummy for the existence of private capital would not capture the relative importance of private funds in the country, or a dummy for the existence of an independent regulator would not capture the degree of independence. The main conclusions of previous studies are summarized below and more details are given in the appendix.

Results are quite robust when proving the importance of private sector participation in spite of the impressive variety of private sector measures, spanning from simple indicators of the existence of private participation to specific modeling of the privatization transactions. There is also a wide range of concern in terms of modeling private sector participation vs. private sector participation with competition. In general, the emerging story is that competition matters and often more so than privatization.

Starting with Wallsten (1999), who explores the effects of telecom reforms on sector performance using a sample of 30 Latin American and African countries in the period 1984-1997, the initial evidence from general cross-country models is that privatization combined with the existence of a separate regulator has more benefits in terms of performance than having privatization alone. Wallsten finds that competition is the reform policy that has the most beneficial effects on performance. Among performance indicators he includes mainlines per 100 people, number of payphones, network connection capacity, employees per 100 mainlines, and price of local phone call. Focusing of Asia in the period 1985-1999, Fink et al. (2001) confirm Wallsten's results and also find that privatization has a greater positive impact in performance if it is accompanied by competition for all performance indicators. They add that corporatization (as an indicator of public sector's determination to improve sector performance) has a significant positive effect on access (mainline penetration), quality (network digitalization), and sector productivity (mainlines per worker).

With a larger sample of countries (86 developing countries during the same period), Fink et al. (2002) measure the effect of competition in local services, regulation, and privatization on mainlines penetration and mainlines per employee controlling for income and population. They show that complete liberalization has a positive effect on performance; that both privatization and competition improve performance; and that the later reinforces the former. Finally, they conclude that the sequence matters.

Generally, the papers trying to model in more detail the reforms draw very similar conclusions. D'Souza and Megginson (1999) model exclusivity periods as a reform variable (to capture more information on competition) and find that it is correlated with capital expenditures in telecoms. Their analysis covers only 28 countries but because it is firm-based, it covers 85 companies. Li and Xu (2004) use variables like the share of private capital, the existence of exclusivity periods, and the procedure of privatization (dummy=1 if privatization was done through public share offer). The sample consists of 166 countries in the period 1981-1998 for privatization regressions. However, when

focusing on the details of competition their sample size shrinks to 43 countries during the period 1990-1998. They find that privatization and competition positively affect performance regardless how they are measured, and that if they work together the gains are even bigger. Regarding the details of reforms, they find that privatizing by offering public shares positively contributes to the performance of the mobile sector. Additionally, they find that granting exclusivity periods reduces the gains from privatization. Wallsten (2004) uses data on 32 privatized telecom firms representing 28 countries and finds that exclusivity periods are associated with significant increases in the firm's sale price and significant decreases in the incumbent's investment in telecom network and in the number of payphones, mobile subscribers, and international outgoing minutes.

The research on regulation points to a number of fundamental questions to be asked by reformers. The importance of sequencing is one of the key ones. Using panel data for 200 countries from 1985-1999, Wallsten (2003) finds that establishing an IRA before the privatization takes place improves telecom investment and penetration. Then with a sample of 33 countries he shows that investors are willing to pay more for firms if a regulatory reform took place prior to privatization. Somewhat surprisingly, he finds that privatization and IRA are negatively correlated with the number of mainlines. Another important contribution is the debate on the relevance of the independence of the regulators. Wallsten (2003) suggests that too much independence may be harmful if politics capture consumers' preferences, as it weakens the relationship between consumers and government and strengthen the relationship between private firms and government. In other words, it might be easier for telecom firms to influence the regulator than for consumers.

A final issue to be considered is the endogeneity of reforms. To illustrate its relevance, Gual and Trillas (2004) first estimate two policy indexes (one for openness and one for the existence of an IRA) and then analyze their impact on performance. They find that pro-entry policies and the creation of an independence agency have positive effects on network penetration and negative effects on productivity. However, after accounting for endogeneity, results are not very robust statistically.

Interestingly, even though there is "political" or conceptual consensus about the importance of institutions and governance for sector performance, a very limited number of studies have included such variables in the analysis. As mentioned before, Wallsten (1999) includes the expropriation risk as a governance control. More recently, Gutiérrez (2003) explicitly recognizes the importance of governance when assessing sector performance. He uses a governance index as an explanatory variable to analyze the effects of telecom reforms on performance in 22 Latin American countries during the period 1980-1997. However, the components of his governance index refer more to particular characteristics of reform policies in the sector than to governance structures per se. After taking into account the endogeneization of policy variables, he finds that regulatory procedures influence network expansion and efficiency.

## 5. NEW ECONOMETRIC EVIDENCE

This section discusses our econometric estimates of the impact of two of the main telecom reform policies (i.e. the presence of private capital and the establishment of an independent regulator) on access, affordability, quality and labor productivity based on the experience during the period 1990-2003. We also test the extent to which reform policies affect differently developed and developing countries.

Focusing on these two reform policies would however tend to ignore the fact that reforms do not take place in a vacuum. Indeed, there are wide differences in governance capacity and commitment across countries, whether developed or developing, which may influence the effects of reforms on performance. The extent to which private capital may be attracted to a country may be driven by more commercial considerations such as the investment risk of the country—and this is the case even if competition and support to private investors are formally part of the laws of the country. Similarly, the scope of action of an independent regulator may be quite different in a country with a high degree of corruption than in a country with a low degree of corruption.

To include corruption and investment risk in the explanation of telecom performance, we rely on two sets of data from the International Country Risk Guide. The first is a corruption index, defined as an assessment of corruption within the political system. It includes financial corruption (like bribes connected with trade, taxes or protection), but it focuses more on actual corruption in the form of excessive patronage, nepotism, job reservations, 'favor-for-favors', secret party funding, and suspiciously close ties between politics and business. The second is an investment risk index, defined as the sum of three subcomponents with equal weights (contract viability or expropriation, profits repatriation, and payment delays). We have transformed the two original indexes so that they now vary continuously between 0 and 1, with zero meaning low value and 1 high value. Table 4 presents basic statistics for these indexes. Developing countries perform worse along both dimensions. Average corruption and investment risk during the period 1990-2003 are 0.54 and 0.47 respectively in developing countries and 0.25 and 0.31 in developed ones.

In our analysis, rather than simply adding corruption and investment risk as determinants of performance, we explicitly account for their interactions with the two reform policies assessed (introduction of private capital and establishment of an IRA).

**Table 4: Average governance 1990-2003**

	Means (standard deviation)		Number of Observations		
	Developing	Developed	Developing	Developed	Total
Corruption Index (0=low 1=high corruption)	0.54 (0.17)	0.25 (0.21)	1373	482	1855
Investment Risk Index (0=low 1= high risk)	0.47 (0.19)	0.31 (0.19)	1373	482	1855

The general model to test can now be specified as follows:

$$Y_{it} = \beta_0 + \text{POL}_{it}' \beta_1 + (\text{DV}_i * \text{POL}_{it}') \beta_2 + \text{GOV}_{it}' \beta_3 + (\text{GOV}_{it}' * \text{POL}_{it}') \beta_4 + X_{it}' \beta_5 + d_i + d(t) + u_{it}$$

where  $i$  indexes a country, and  $t$  time.  $Y$  is an output variable which measures one of the performance dimensions covered here.  $\text{POL}$  is a vector of policy variables,  $\text{GOV}$  is a vector of governance variables,  $\text{DV}$  is a dummy equal to one if a country is developed and 0 otherwise, and  $X$  is a vector of additional regressors. Finally, a linear time trend  $d(t)$  takes into account technological advances.<sup>12</sup> The model allows for country fixed effects  $d_i$ . Identification of the model hence stems from the deviation of within countries variation in the regressors around a common macroeconomic trend. All regressions are weighted by the average population size in the country between 1990 and 2003.

Our interest is to understand how some major telecommunication reforms affect access, affordability, quality, and productivity depending on the institutional setting. We are particularly interested in understanding if higher corruption and investment risk dampen (or perhaps magnify) the effect of reforms. This is the rationale for introducing in the regression the interaction between  $\text{GOV}$  and  $\text{POL}$  variables. However, one has to be cautious in drawing conclusions from the coefficients associated to these interactions. Countries with lower governance are also generally countries with lower income and one has to be sure not to attribute to poor governance the heterogenous effect of reform policies across countries at different stages of development. This is the reason why we also add the interaction between policy ( $\text{POL}$ ) and development level ( $\text{DV}$ ) variables. This allows us to identify the heterogenous effect of reform policies on performance for different institutional settings, net of the heterogenous effect that these reforms potentially have in countries at different stages of development.

For the policy variables,  $\text{POL}$ , we rely on two dummy variables. The first,  $\text{PRIV}$ , reflects whether the country has opened its doors to private operators. The second,  $\text{IRA}$ , reflects whether the country  $i$  at time  $t$  has established an independent regulatory agency. We also model the interactions between the two ( $\text{POL}_{it}' = [\text{PRIV}_{it} \text{IRA}_{it} \text{PRIV}_{it} * \text{IRA}_{it}]$ ).

As measures of governance, we use the two indexes discussed earlier: corruption and investment risk ( $\text{GOV}_{it}' = [\text{CORR}_{it} \text{INVRISK}_{it}]$ ). The term  $\text{GOV}_{it}' * \text{POL}_{it}'$  picks up interactions between governance and policy variables. This is a vector that contains all interactions of  $\text{CORR}$  and  $\text{INVRISK}$  with  $\text{IRA}$  and  $\text{PRIV}$ . Because the model controls for country fixed effects, the main effects of the  $\text{DV}$  variable are also included in the model (but not identified).

Two important controls are included in vector  $X$ , income and population. Specifically, we use the GDP per capita in 2000 constant US dollars to capture the purchasing power of the population; and the total population to capture the size of the market from the demand side.<sup>13</sup>

The unbalanced panel has 2,856 observations including data for 204 countries during the period 1990-2003. 153 countries were classified as developing (if their 2001

<sup>12</sup> Results are essentially unchanged when including year dummies.

<sup>13</sup> Results are essentially unchanged without controlling for population size.

GNI per capita was equal or less than \$9,205); and 51 countries were classified as developed (if their 2001 GNI per capita was higher than \$9,205). As indicated earlier, while data coverage is generally quite large, there is a great deal of variability across variables. For instance, while we have almost no missing values for access, the sample almost halves when we consider non missing observations for quality, and it falls by about one fourth if one looks at affordability and institutional variables. For every performance indicator, we used the largest possible sample. To reduce sample selection bias, the samples include countries that have reformed as well as an important number of countries that have not reformed.

Our assumption is that the adoption of a certain policy is conditionally exogenous to the error term in (1). Because we control for country fixed effects, a linear trend, and GDP per capita, we completely absorb differences in the output variables due to intrinsic time unvarying characteristics of each country (e.g. their history), changes in economic performance and the generalized trend in privatization and IRA adoption. Ultimately, we claim that conditional on these covariates, reform policies are uncorrelated to the error term in (1) and that the GLS estimates of the coefficients on the policy variables are consistent.

Table 5 summarizes the results. Each column of the table refers to a different output related to telecom performance. The first column reports the results for access measured by the log of telephone subscribers over population, columns 2 to 4 refer to affordability, proxied by the log of the cost of a local phone call, and the logs of the residential and business monthly subscription fees. Column 5 refers to quality, measured by the log of reported telephone faults per 100 mainlines. Column 6 presents results for the log of mainlines per employee. Overall, the statistical test provided at the bottom suggests a good fit of the models.

It is difficult to ascertain the average effect of the policies of interest by looking at table 5. Simply looking at the coefficient of the reform policy of interest would be misleading. This is because the model includes the interaction between reform policies and the dummy for developed countries (DV) plus the interaction between reform policies and governance indexes. All this information needs to be considered jointly to be able to make a reliable statement on the impact of reform policies based on these results. Looking at the coefficients in the first three rows of table 5 would only tell us about the effect of reform policies in developing countries (the omitted group) when the corruption and investment risk indexes are zero.

Table 5 is however quite useful in assessing how policies interact with the governance variables. For instance, it shows that privatization offsets the effect of corruption on our measure of access and on one of our measures of affordability. However, it has no effect on the impact of corruption on labor productivity or quality. Privatization has an impact on the effect of investment risk on all performance indicators. It offsets the effect of investment risk on access and affordability but it reinforces the effect on quality and labor productivity.

With respect to the interaction between IRAs and governance, it is interesting to note that, all other things being equal, the introduction of an IRA reduces the effect of corruption on access rates and labor productivity, as the interaction variables for each

performance indicator have a significant negative sign. Also, the introduction of an IRA has no significant effect on the impact of corruption on prices. Regarding the risk index, table 5 shows that the introduction of an IRA offsets the effect of investment risks on prices, quality and labor productivity.

Note that these interaction coefficients have a “two-way” reading. They can also be used to show the effects of the governance environment on reform policies. Corruption offsets the effects of an IRA on access, quality and productivity. It also offsets the effects of privatization on access and affordability. Similarly, investment risk increases the impact of IRA on labor productivity and quality but offsets the effects on the price of local calls.

Interestingly, row 3 shows that private capital and IRA hardly interact, except for the price of local phone calls. In this case, the introduction of both policies jointly implies a lower average price. In other words, the two policies reinforce each other. Comparing this with the partial effect of these policies on prices, it is interesting to note that considered jointly they are good for affordability, while considered separately they hurt it.

At the more general level, as in most of these models, table 5 shows that the income levels are generally significant for all performance indicators, although less so quality. So is population, except again for quality but also for usage price. Population growth is also associated with a reduction in connection fees, reflecting the fact that network costs can be shared among a larger number of users as population (and access and usage) grow.

**Table 5: Econometric results**

		(1)	(2)	(3)	(4)	(5)	(6)
		Ln Telephone Subscribers/ 1000 people	Ln Price of Local Telephone Call (2000 US cents-3min)	Ln Monthly Residential Subscription Fee (2000 US\$)	Ln Monthly Business Subscription Fee (2000 US\$)	Ln Phone Faults (reported faults/100 mainlines)	Ln Mainlines per Employee
(1)	Privatization	0.439*** [0.088]	0.905*** [0.138]	0.716*** [0.164]	0.648*** [0.157]	-0.472** [0.207]	0.029 [0.090]
(2)	IRA	0.047 [0.096]	0.562*** [0.149]	0.121 [0.173]	0.123 [0.167]	0.446** [0.224]	-0.102 [0.102]
(3)	IRA * Privatization	0.014 [0.037]	-0.253*** [0.059]	-0.015 [0.066]	-0.075 [0.063]	0.078 [0.086]	0.031 [0.040]
(4)	Privatization * Developed	-0.526*** [0.067]	-0.064 [0.103]	-0.548*** [0.121]	-0.309*** [0.116]	-0.423** [0.202]	-0.285*** [0.067]
(5)	IRA * Developed	0.014 [0.076]	-0.334*** [0.112]	-0.264** [0.131]	-0.114 [0.126]	-0.306 [0.221]	-0.253*** [0.076]
(6)	Corruption Index (0=low 1=high)	0.687*** [0.058]	0.435*** [0.130]	-0.034 [0.151]	0.046 [0.145]	-0.202 [0.199]	0.566*** [0.057]
(7)	Privatization * Corruption	-0.216** [0.098]	-1.115*** [0.175]	-0.524*** [0.187]	-0.455** [0.181]	0.150 [0.277]	-0.082 [0.116]
(8)	IRA * Corruption	-0.280** [0.122]	0.144 [0.198]	0.079 [0.225]	0.200 [0.217]	-1.339*** [0.323]	-0.584*** [0.142]
(9)	Investment Risk Index (0=low 1=high)	0.508*** [0.079]	0.340** [0.147]	0.016 [0.160]	0.232 [0.156]	-1.670*** [0.212]	-0.015 [0.078]
(10)	Privatization * Investment Risk	-0.186* [0.106]	-0.746*** [0.183]	-0.371* [0.198]	-0.348* [0.189]	0.672** [0.281]	0.390*** [0.117]
(11)	IRA * Investment Risk	0.088 [0.105]	-0.702*** [0.180]	0.146 [0.189]	-0.145 [0.186]	0.655** [0.280]	0.861*** [0.116]
(12)	Ln GDPpc (2000 US\$)	2.173*** [0.050]	-0.619*** [0.161]	-1.516*** [0.174]	-0.725*** [0.167]	0.386* [0.219]	2.383*** [0.059]
(13)	Ln Population	1.433*** [0.242]	-0.313 [0.425]	-4.696*** [0.477]	-2.367*** [0.474]	-0.821 [0.635]	1.148*** [0.262]
(14)	Time Trend	0.091*** [0.005]	-0.050*** [0.009]	0.065*** [0.010]	0.010 [0.010]	-0.080*** [0.013]	0.049*** [0.005]
	Constant	-215.877*** [7.601]	112.275*** [14.207]	-43.055*** [14.152]	19.473 [14.849]	169.524*** [19.470]	-131.740*** [8.147]
	Observations	1597	1322	1412	1393	926	1436
	R-squared	0.99	0.85	0.81	0.84	0.95	0.96
	R-squared within	0.94	0.36	0.19	0.13	0.43	0.87
	Number of countries in sample	126	118	123	123	115	125

- Standard errors in brackets \* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

- R-squared is significant at the 1% level in all regressions.

- Developing countries are those in which 2001 GNI per capita was equal or less than \$9,205.

- All regressions include country fixed effects.

- Estimation technique: GLS.



Table 5 results are useful but they do not provide us with a correct assessment of the average total effect of reform policies across countries. If we add the coefficients in rows 4 and 5 to those in rows 1 to 3, we get the effects of reform policies in developed countries assuming no corruption and no investment risk. To account for the effect of corruption and investment risk, we could further add their coefficients assuming different levels of corruption and investment risk. Thus, all these calculations give us the effects of reforms under specific scenarios and not the average total effect of reforms across countries. The total average effect of reforms depends on these complex interactions and can be obtained by calculating the marginal effects. To facilitate the interpretation of the results, we have computed the marginal effects for the variables of interest.<sup>14</sup> We report them in table 6.

**Table 6: Marginal effects in log units**

	Ln Telephone Subscribers /1000 people	Ln Price of Local Telephone Call (2000 US cents-3min)	Ln Monthly Residential Subscription Fee (2000 US\$)	Ln Monthly Business Subscription Fee (2000 US\$)	Ln Phone Faults (reported faults/100 mainlines)	Ln Mainlines per Employee
<i>Effects of private capital:</i>						
All countries	0.134***	-0.032	0.174***	0.185***	-0.198***	0.099***
Developed (DV=1)	-0.256***	-0.080	-0.222**	-0.039	-0.508***	-0.110**
Developing (DV=0)	0.270***	-0.016	0.327***	0.270***	-0.086	0.175***
<i>Effects of IRA:</i>						
All countries	0.548	-4.488***	1.103	-0.877	4.333**	5.468***
Developed (DV=1)	0.558	-4.739***	0.913	-0.960	4.109**	5.282***
Developing (DV=0)	0.544	-4.405***	1.177	-0.846	4.415**	5.536***

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

We find in table 6 that PRIV has significant impact on 5 of our 6 measures of performance. On average, private capital is associated with an increase in the number of telephone subscribers, residential and business subscription fees, and a reduction of telephone faults. It also was associated with enhancements in labor productivity. In other words, private capital leads to more and better service, but at a price to the consumer. Additionally, we find that the presence of private capital affects differently developing and developed countries. More specifically, it is associated with an increase in the number of telephone subscribers per 1000 people and an increase in subscription fees in developing countries, but a decline in developed ones. Telephone faults decline is only statistically significant in developed countries, implying that most of the improvements observed in the poorest countries can be attributed to technological change rather than to the access to private operators. Finally, private capital improves labor productivity in developing countries while it deteriorates it in developed ones.

The introduction of an IRA proved to be less effective than PRIV, in the sense that its effects are significant in only 3 of our 6 measures of performance. On average, it

<sup>14</sup> To compute the marginal effects of PRIV (or IRA) we first calculated the derivate of equation (1) with respect to PRIV (IRA), setting all the other variables to their average value, and then we tested the hypothesis that the derivate is equal to zero.

would bring down the price of local calls, intensify reported telephone faults, and improve labor productivity. With respect to the price of local calls, the results suggest that an IRA is important to ensure local users that the potential gains from technological progress are not offset with the increase in local tariffs often associated to tariff rebalancing.<sup>15</sup> Regarding quality, the deterioration associated with the existence of an IRA probably reflects the fact that an IRA does a better job at measuring quality than a self-regulated operator. Thus, reform policies initially may end up increasing measured faults, even if they ultimately improve quality.<sup>16</sup> Finally, results suggest that the strongest effect of the introduction of an IRA is the enhancement of labor productivity.

When comparing the effects of an IRA in developing and developed countries, table 6 shows that these effects have the same sign in both groups but are stronger in developing countries in terms of labor productivity and quality, and are stronger in developed countries in terms of prices. Somewhat surprisingly, the introduction of an IRA has no statistically significant impact on access and on the fixed component of the tariff paid by users, whether residential or business.

## 6. CONCLUDING REMARKS

We first reported basic data on telecom reform policies and performance outputs which hinted at a number of correlations. Based on this very basic data analysis, countries with private capital and/or an independent regulatory agency (IRA) seem to have, on average, more subscribers, lower local call price, lower fixed costs, lower faults, and higher labor productivity. We also observed that countries that have reformed present, on average, better performance outputs than countries that have not reformed. However, there seemed to be differences in the impact of reform policies between developing and developed countries.

We then provided a more formal assessment of these apparent correlations through an econometric analysis to refine the conclusions emerging from the basic data analysis. More specifically, we could confirm that countries with private capital have more subscribers, lower local call price, lower faults, and higher labor productivity. However, in terms of fixed costs, econometric results differ from the basic data analysis. We found that private capital is actually associated with an increase in residential and business subscription fees, which is consistent with the tariff rebalancing that typically takes place when ending direct subsidies as part of most reforms. With respect to the independent regulator, we could confirm that countries with an IRA have lower local call price and higher labor productivity, but we found again some discrepancies with the basic

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<sup>15</sup> Tariff rebalancing usually takes place as part of the reforms after the government eliminates historical cross-subsidies that favor local calls.

<sup>16</sup> In the absence of a good measure of the probability of detection we cannot but remain agnostic about the true effect of reform policies on the quality of service. For instance, if we further control for log subscribers in the quality equation the coefficient on PRIV\*D<sub>V</sub> grows, suggesting that congestion externalities due to the enlargement of the sector following privatization do not explain the results.

data analysis. First, we found that the existence of an IRA was associated with more faults. Second, we actually found that the regulator does not have a statistically significant effect on the number of subscribers and fixed costs.

The less than systematic success of reforms across indicators may be explained by the fact that governance interferes with the effects of reforms (although governance may also substitute for or trigger reforms when there is no willingness to reform). This is what the tests conducted here seem to indicate. We found that corruption has, on average, statistically significant beneficial effects on performance in terms of access and labor productivity in countries that have not reformed. However, we also found that in countries that committed to reforms, reform policies offset the beneficial impact of corruption on performance. Overall, the main result to retain may be that even though corruption may lead to some performance improvements in the presence of red tape and resistance to change, reform policies can lead to stronger and better performance outputs in a much more ethical way. Increases in investment risk were associated with improvements in access and quality; however, the presence of private capital offsets these beneficial effects.

Regarding the differential effects of reform policies in developed and developing countries, the paper provides additional new insights. The presence of private capital influences more dimensions of performance across country groups than the establishment of an IRA. However, the effects of private capital usually work in opposite directions for developing and developed countries. Developing countries benefit from private capital in terms of access and labor productivity, but they get worse in terms of residential and business subscription fees. In contrast, developed countries benefit from private capital in terms of residential subscription fees and reported faults, but they get worse in terms of access, and labor productivity. Even though IRA affects fewer measures of performance, its effects have the same sign for developing and developed countries. Thus, in this case differences between developing and developed countries are given in terms of magnitude. Developed countries benefit more in terms of local call price and their phone faults increase less, while developing countries benefit more in terms of labor productivity.

Finally, while these results are important for policymakers, they also hint at complex issues and trade-offs which deserve a much more refined analysis than the one we have been able to produce here. Possible extensions to our work include a better assessment of reform processes and sequences as well as a much less simple modeling of the degree of reforms from a cross-country perspective. At the more technical level, it would be interesting to generate *good* instruments to relax the assumption that reforms are exogenous to sector performance.

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# APPENDIX: A survey of empirical studies on the effects of telecom reform

Author	Sample	Year	Performance Indicator Explained	Explanatory variables <sup>1</sup>											Methodology <sup>2</sup>	Results
				1. Corporatization dummy	2. Reform legislation passed	3. Price cap regulation	4. Independent regulatory agency dummy	5. Regulatory index	6. Privatization	7. Competition	8. Policy interactions	9. Liberalization: priv * ira * competition	10. Sequence	11. Expropriation risk		
Ros 1999	110 countries	1986-1995	Mainlines per 100 people, growth in mainlines, mainlines per employee, growth in mainlines per employee						X	X					Panel data: FE with instrumental variable.	Privatization has positive effect on mainlines. No evidence that it leads to higher growth in mainlines in countries with GDPpc<10000. Privatization has positive effect on mainlines per employee and its growth. Competition has positive effect on mainlines per employee.
Boylaud & Nicoletti 2000	23 OECD	1991-1997	Productivity, prices, and quality of long distance service & mobile service				X		X	X	X	X			Panel data: country FE and RE. F, Breush-Pagan, and Hausman tests to select between RE and FE. Technique not specified.	Comp has a strong positive impact on productivity and quality, and reduces prices. No evidence on effect of privatization.
Wallsten 2001	30 countries: 15 AFR, others in LAC	1984-1997	Mainlines per 100 people, number of payphones, connection capacity, employees per 100 mainlines, price of local call		X		X		X	X	X		X		Panel data: country and year FE. Technique not specified.	Competition has positive effect, and matters the most. Priv has negative effect on mainlines and connection capacity. Priv* ira has a positive impact on connection cap. And mitigates negative impact of priv.
Fink et al. 2001	12 Asian	1985-1999	Mainline penetration, network digitalization, mainlines per worker	X					X	X	X	X			Panel data: country FE. Technique not specified.	Priv has bigger impact on performance if accompanied by competition. Liberalization has positive effect.
Fink et al. 2002	86 developing : 39 AFR, 10 MNA, 25 LAC,	1985-1999	Mainline penetration, mainlines per employee				X		X	X	X	X	X		Panel data: country FE and time trend. Two-stage estimation (first estimate mobile penetration), then use it in main eq.; GLS. Kmenta's cross-sectionally heteroscedastic and time-wise autocorrelated (CHTA) approach.	Liberalization has positive effect on performance, competition and priv better together, and sequence matters.
Gutiérrez 2003	22 Latin America	1980-1997	Mainlines per 100 people and mainlines per employee			X		X	X	X					Panel data: country and year FE. Accounts for endogeneity of policies. Static model: two-stage LSDV. Dynamic models: GMM (Anderson-Hsiao & Arellano-Bond)	Competition and privatization have positive impact on mainlines, and mainlines per employee. Also, openness and divestment have positive effects.
Ross 2003	20 Latin America	1990-1998	Mainlines in operation per 100 people, growth of mainlines in operation per 100 people, mainlines in operation per employee			X	X		X	X					Panel data: FE and RE. Breush Pagan and Hausman tests. Instrumental variable approach: estimating first policy variables with probits.	Privatization and ira have positive effect on teledensity, operating efficiency. Competition and price cap have positive effect on teledensity
Wallsten 2003	197 countries. Sample for implied firm's value: 33 countries.	1985-1999	Telecom investment, mainline penetration, mobile subscribers, and implied firm's value				X		X		X		X		Panel data: country and year FE. Technique not specified.	Negative effect of ira alone. Privatization alone has negative effect on mainlines and positive on investment and mobiles. Ira before priv has positive effect on mainlines, investment, and mobiles.
Wallsten 2004	32 private firms, 28 countries	1987-2000	Firms' sale price, incumbent's investment in telecom, payphone, mobile penetration, international calling							X					Panel data: country and year FE for investment equation. Technique not specified.	Exclusivity periods associated with increase in firm's sale price, and have negative effect on mainlines, investment, mobiles, and payphones.
Gual & Trillas 2004	37 countries: 25 high income, 6 lac, 2 mna, 1 sar, 3 afr	1998	Asymmetric deregulation, reg. independence, network penetration, productivity				X			X					OLS, IV (with probit equation). They first estimate policy variables and then use them to assess the their effect on performance (they don't use policy dummies).	Weak protection to investors, quasi-rents, and large incumbent have positive influence in the creation of ira. ira and openness have positive impact on mainline penetration and negative impact on productivity, results are not too robust
Li & Xu 2004	177 priv, and 43 comp	priv 1990-2001, comp 1990-2001	Per capita investment in telecoms, employment in telecoms, mainlines per 100 people, mobiles per 100 people, price of local calls, and labor productivity.						X	X	X				Panel data: country FE, 2SLS.	Full privatization proved to have positive impact in multiple outputs, while partial privatization was not significant. Priv and comp have positive effect, and having both would bring more gains than having one

(1) Policy variables = 1 to 10; governance = 11. Most models included a combination of the following as other controls: international settlement payments, mainline penetration, investment in the sector, prices, waiting list for mainlines, population, urbanization, GDP, aid, imports, and exports. (2) Possible techniques are: OLS, 2SLS, GLS, LSDV, GMM static, GMM dynamic (Arellano-Bond), and IV among others.