Independent Regulation and Telecommunications Performance in Developing Countries

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Abstract:

In response to the recent booming of telecommunications regulators in developing countries, this paper attempts to econometrically explore the impact of independent regulation on basic infrastructure deployment.

Based on the insights of the political economy of regulation and on the hold-up theory, I intend to prove that a country in which industry and political pressures on independence of the regulator are relatively low should show relatively a more rapid growth rate of infrastructure penetration. I propose to establish such a link by using data on 30 African and Latin American regulators and telecommunications markets during the period 1990-1999.

On the whole, the pooled estimates suggest that independent regulation does matter in having a relative positive impact on the growth rate of telecommunications penetration. Yet, a large fraction of the variance remains to be explained, meaning that the set of explanatory variables used in the regression could be refined and extended. Therefore, further research is needed to quantify more precisely the actual impact of regulatory independence.

(165 words)

I INTRODUCTION

During the 1990's, regulators have emerged as key players as a result of rapid technological change, low performance of incumbent operators, and the WTO Agreement on Basic Telecommunications. In a little over a decade their number worldwide has grown from a mere 12 to 102 today.

Regulators are usually thought of as part of the "economic institutions of capitalism". On the one hand, the ultimate test of their efficacy lies in the impact they have on performance. On the other hand, with the rise of corporatizations and privatizations, the liberalization of various market segments, and the change in the nature of services offered, the need for a regulator as independent referee becomes a necessity. Thereby, the specific question that I seek to answer is, how do independence characteristics of the regulator affect telecommunications performance ? This is a topical question. Not only are most countries now trying to assess the degree of independence of their regulator, but also independent regulation tends to be more and more considered as a cornerstone of reform.

We have a good theoretical understanding of the importance of independent regulation. Our empirical knowledge of its potential effects in developing countries is much less comprehensive. Indeed, the empirical work to date consists largely of case studies and comparisons of telecommunications performance before and after the creation of a regulator. These studies have provided important insights into the effects of regulation on sector performance, but it rarely comes to econometric tests. Furthermore, no previous studies of which I am aware have attempted to explore the effects of independence of the regulator on telecommunications infrastructure deployment.

Therefore, the paper main contribution lies in its endeavor to econometrically analyze the link between basic telecommunications infrastructure deployment and independence level of 30 African and Latin American regulators during the period 1990-1999.

The paper proceeds as follows. Section II first reviews the main insights from scholarly literature on political economy of regulation and from empirical studies on the effects of regulation in developing countries. This aims at defining the concept of independent regulation and establishing its potential impact on basic infrastructure deployment in the telecommunications sector. Then, I combine the outcomes of both theory and empirical literatures to fashion a specific hypothesis about independent regulation. This hypothesis is that *countries in which industry and political pressures on independence of the regulator are relatively low should show relatively better growth rate of basic telecommunications infrastructure deployment*.

In the remaining sections, I test this hypothesis in combination with relevant economic variables, to predict cross-national variation in the growth rate of basic telecommunications infrastructure penetration. Section III discusses the key variables and describes the methodology of the empirical analysis. Section IV presents the findings. Consequently, section V concludes with future issues.

II THEORY

Defining a theoretical framework for analyzing regulation is an important prerequisite to an empirical discussion of regulatory effects (Joskow and Rose, 1989). That is the reason why I discuss now the scholarly literature that underpins our hypothesis.

This literature falls into the broad category of political economy of regulation. I summarize the primary insights from this body of theory as it tackles the definition of independent regulation and argues its expected implications on the growth pattern of basic infrastructure deployment in the telecommunications sector.

II.1 Defining Independent Regulation

A significant theme in the literature on political economy of regulation is addressed to the meaning and implications of independent regulation. Yet, this notion is problematic *per se*. Indeed, although it is widely accepted that independence is a necessary feature for an effective regulator, the concept proves difficult to define because of its multiple dimensions. As a result, there are several definitions of it.

For instance, through the WTO Agreement on Basic Telecommunications, many countries commit, among other things, to establish a regulator that is separate from the incumbent operator. The European ONP Framework Directive defines further an independent regulator as a body legally distinct and functionally independent of telecommunications organizations. Yet, this widely accepted attribute of independence is only a starting point for defining its meaning. In fact, a number of new regulatory organizations are described as independent by their enabling legislation. However, the structure of regulators expressing independence does vary. Many, if not most, are separate from, and subject to, the governmental ministry overseeing telecommunications. Some are part of the ministry itself, and fewer still are not subject to a ministry.

As Melody (1997) points out, the term "independence", as used in the context of telecommunications reform, is often misunderstood. It does not imply independence from government policy, or usurping the power to make policy, but rather independence to implement policy without undue interference from politicians or industry lobbyists. It implies not only the capability to acquire special regulatory functions but also to implement them without interference.

Moreover, according to Michael Powell, the Chairman of the U.S. Federal Communications Commission, to be independent, not only should a regulator be physically and operationally separated from those it regulates, but also be empowered to carry out policy by making objective, well-reasoned, written decisions arrived at through transparent processes, and based on a complete, public record. Regulators should be free from undue political influence during this process, and impartial decisions based on the record should not be undermined for political reasons. Finally, the scope and substance of a regulator's jurisdiction should be clearly mandated by statute, and there should be adequate funding to carry out its responsibilities.

This anthology of definitions born in mind, in the next section, I put forward evidence from the hold-up theory, supported by empirical studies, of the need for independent regulation and of its potential impact on basic infrastructure deployment in the telecommunications sector.

II.2 The Hold-up Theory

As demonstrated, for example, by the case studies in Galal and Nauriyal (1995) and Levy and Spiller (1996), the confluence of economic opportunity and political motivation gives rise to strategic behaviors on the part of stakeholders and creates inherent problems in the provision of telecommunications services.

Indeed, as Henisz and Zelner (2000) argues, the deployment of a basic telecommunications infrastructure provides a classic example of hold-up problem. As we see in the previous section, theoretically, the government sets up the regulatory rules that the independent regulator is in charge of implementing and enforcing vis-à-vis the regulated telecommunications firms. Within this context, hold-up occurs mainly in two ways. One is in the case of absence of a credible commitment by the government not to expropriate capital assets or the returns generated by firms. The other is in the case of poor bureaucratic norms and incentives, and lack or asymmetry of information, making the regulator vulnerable to capture by partisan influences. I consider each aspect in turn.

The absence of a credible commitment by the government not to expropriate telecommunications firms increases the risk associated with investment in telecommunications assets that are largely sunk. Moreover, Levy and Spiller (1994) argue that economies of scale in telecommunications services provide a government seeking to curry favor with the electorate with the strong incentive to expropriate a telecommunications firm's returns once the latter has deployed infrastructure in the ground. Accordingly, investors will only believe government pledges regarding future regulatory policy to the extent that they are credible and do not jeopardize investments.

In their study on regulation in seven developing countries, Galal and Nauriyal (1995) contrast their assessment of the regulatory regimes with sector performance. They argue as well that the incumbent operator's performance depends on the credibility of government commitment with respect to upholding the terms of the contract. Credibility, in turn, depends on the extent to which institutional safeguards, such as a powerful independent regulator, are in place. When such safeguards are absent, the cost to the government of overturning prior decisions falls and the likelihood of rent-seeking in resource allocation on the part of political actors rises (Henisz and Zelner, 2000).

Hold-up takes place also when the regulator can either lose, or never have, the independence to make professional decisions on its merits because of undue influence either from politicians, politically driven ministries, or from the regulated monopoly. In fact, the regulator is all the more vulnerable to capture by partisan influences because there is the conjunction of poor bureaucratic norms and incentives, and lack or asymmetry of information.

Indeed, as Melody (1997) argues, poor bureaucratic norms and routine administrative activities hamper the regulator to adapt its operating methods to the environment in which it must function. Moreover, as the regulator must apply the government's comprehensive telecommunications policies to the sector as a whole, lack of information prevents the regulator to be fully aware of technological and market trends and be capable of forecasting, planning and proactive inquiry. These difficulties do not allow the regulator to implement the government's policies effectively, to resolve industry problems in a progressive rather than an *ad hoc* manner, and to act as a beacon for government on issues that will require policy attention from government from time to time. In other respects, structuring the relation between the government and the regulator is relatively difficult because the regulator usually remains a part of the government.

Some case studies on telecommunications reform in developing countries, such as Laffont and Tchéché N'Guessan (2001), show that although a regulator is powerful in law, in practice it can be very weak faced with the so-called regulated firms. For example, without strong enforcement powers vested in the regulator, a dominant incumbent operator will be able to deny interconnection to entrants on reasonable terms and physically restrict access or provide technically inferior service to its rivals' customers. The main reason for this is that the incumbent operator stands in the bottleneck of the telecommunications value chain, restraining opportunities for new players because of its dominant position (Melody, 1997).

Furthermore, according to the capture theory of regulation, firms try to capture the regulatory process because each firm has a lot at stake. They have the incentive and the opportunity to successfully invest resources in lobbying for regulation, when such regulation provides direct monetary subsidies, constraints on substitute products or subsidies on complementary products, easier price-fixing / collusive atmosphere, and incumbent firms with the ability to control entry by potential new rivals.

Finally, it follows from this section that independent regulation is needed mainly to tackle the hold-up risks that arise in the regulatory contractual arrangement between the regulated firms, the government, and the regulator. From this point, I use the combination of theory and empirical studies to fashion a specific hypothesis about the effect of independent regulation on basic telecommunications infrastructure deployment in the following section.

II.3 Hypothesis

The literature on political economy of regulation offers important insights into the institutional environment that provides credible safeguards against capture of regulation. Indeed, institutional environment that are unable to provide such commitments promote increased rent-seeking behaviors, which creates an additional channel through which sector performance is vulnerable to hold-up. Therefore, institutional safeguards, such as a powerful independent regulator, have significant potential effects on the growth of infrastructure penetration because the regulator's ability to make fair professional decisions on its merits is directly related to the perception investors have of its independence. It means that depth and scope of benefits of regulation may derive from the establishment of effective independence.

Moreover, empirical literature teaches us that in most developing countries, the telecommunications sector is the first to be liberalized.

Thereby, because of lack of precedents administrative law in these countries usually makes no provisions for such institutions as independent regulators (Galal and Nauriyal, 1995). Accordingly, a newly created telecommunications regulator will generally lack autonomy from the sector ministry and from the incumbent operator, which is likely to lead to arbitrary policy changes, sectarian decision-making, regulatory uncertainty for consumers and service providers, and mistrust on the part of investors.

In the light of the previous discussions, I advance the following hypothesis:

Countries in which industry and political pressures on independence of the regulator are relatively low should show relatively a better growth rate of basic telecommunications infrastructure deployment.

In the remaining part of the paper, I test econometrically this hypothesis in combination with relevant economic variables to predict cross-national variation in the growth rate of telecommunications penetration.

III EMPIRICAL ANALYSIS

In this part, I describe successively the key variables and the methodology used to estimate the effects of independent regulation on basic telecommunications infrastructure deployment.

III.1 Key variables

In accordance with the theory and empirical literature summarized in Section II, the key variables in the analysis measure a country's penetration level of basic telecommunications infrastructure and the level of regulatory independence. Data on the former were acquired from the World Bank (2001) and International Telecommunications Union (ITU, 2000a). Data on the latter came from author's search and ITU (2000b).

Data set contains 300 observations from 30 African and Latin American countries over the period 1990 - 1999. I summarize the key variables in turn as follows.

Telecommunications Infrastructure

Following standard practice, I measure infrastructure penetration as the number of main lines per 1,000 inhabitants. A main line is defined as "a telephone line connecting a subscriber's terminal equipment to the public switched telephone network" (World Bank, 2001). This measure is the variable, noted *MLINESPT*, to be explained in the econometric model that is further described below.

The World Bank has compiled data on main lines as part of its World Development Indicators database. The database is derived from various other compiled sources, and in its entirety covers up to 207 countries during the period 1960 - 1999. Note should be taken that I do not consider the mobile cellular penetration because mobile industry is usually newer, less regulated and more innovative than the fixed-voice industry over the sample period.

Independence Level

This variable reflects the extent to which a telecommunications regulator is actually independent from industry and political pressures in order to be perceived by investors as a credible safeguard against hold-up. It is the explanatory key variable in our model. It is identified by the notation *INLVL*.

In order to construct a measure that is comparable over both time and a wide sample of countries, it was necessary to reduce the number of relevant independence features to a few analytically tractable dimensions, focusing on a limited set of indicators that catch the main repercussions on telecommunications penetration and that deal with a major issue: the hypothetical discrepancy between actual and in-law regulatory independence.

Moreover, the choice of these indicators ought to have been dictated by the possibility to turn the qualitative information on regulatory provisions into quantitative variables, the possibility to rank cross-country differences in the regulatory independence provisions along a meaningful and (possibly) uncontroversial scale, and the existence of sufficient variability across countries in such a way that *INLVL* can be considered as an objective and relatively exhaustive rating of independent regulation.

Consequently, these indicators could not address the finer issues related to regulatory design for which available cross-country information is too recent and sparse to allow in-depth empirical analysis, although the governance mechanisms of the regulator (attributes such as a collegiate body, an adequate funding and staffing, etc.) might have important effects on telecommunications performance.

In the light of the previous considerations, the measure of regulatory independence (*INLVL*) emphasizes and combines the two following features:

- on the one hand, the statutory independence, noted *STATIN,* that covers both functional and operational separation of the regulator from the government and from those it regulates. Therefore, *STATIN* can take either the value 0 (the regulator is not independent from neither the regulated firms nor the government) or 1 (the regulator is independent from only one of them) or 2 (it is independent from both);

- on the other hand, the range of regulatory functions actually vested in and empowered by the regulator to carry out telecommunications policy. The associated variable is noted *FUNCIN*. As for regulatory functions that are relevant with respect to the problematic, there are six of them: issuing license and controlling of license requirements, authorization of interconnection charges of the incumbent / dominant operator, dispute arbitration, regulation on tariffs, regulation on quality of service, and numbering. Moreover, these regulatory functions have the particularity to be commonly recognized as classic tools used by any regulator. *FUNCIN* can take integer values from 0 to 6, depending on the number of regulatory functions granted to and used by the regulator.

The adopted measure of the regulatory independence level, *INLVL*, is the product of the multiplication of *STATIN* by *FUNCIN*. Indeed, following the discussions of the Section II, it appears that regulatory functions and statutory independence go hand in hand. I assume they are the two sides of the same concept. Yet, to rank cross-country differences in *INLVL* I divided by 12 (the maximum score of the multiplication) in such as way that I obtained a scale between 0 and 1.

III.2 Methodology

Our methodological approach to measuring the effects of the variable *INLVL*, defined above, on main lines penetration, *MLINESPT,* consists broadly in comparing matched samples of "independent" and "dependent" regulators in order to attribute differences in performance to the extent to which a regulator is independent. This approach relies on cross-sectional / time-series variation, comparing the same countries operating under different and changing regulatory independence characteristics. Although the sample of countries is small and not random, these 30 countries are diverse enough in their level of economic development as measured by their average real GDP per capita, their average telecommunications penetration, the timing of the creation of their regulator, their score in the *INLVL* scale (*cf. supra*), the number of mobile cellular operators, and the extent of the divestiture of their incumbent operator(s). Moreover, the average year of the creation of regulators for the sample countries is 1995.

The methodology of the empirical analysis is based on the specification of the model and on the econometric estimation method. Both are described successively below. The sources of data used in the paper are recapitulated in Annex - Table 1.

Model Specification

The core specification for our econometric analysis proceeds from the theory discussion in Section II. The core specification is:

$$\begin{aligned}\Delta MLINESPT_{it} = {} & C + \beta_1 \ln MLINESPT_{it-1} + \beta_2 INLVL_{it-1} + \\ & \beta_3 (INLVL_{it-1} \times \ln MLINESPT_{it-1}) + \beta_4 \ln GDPPC_{it-1} + \\ & \beta_5 \Delta URBANPOP_{it-1} + \beta_6 PUBOP_{it-1} + \beta_7 MOBOP_{it-1} + \\ & \varphi YEARDUM + \varepsilon_{it}\end{aligned}$$

I use the notation ΔX_{it} to represent the percentage growth in variable X between time t and time t - 1 and the notation ln X to represent the natural logarithm of X.

Thereby, I specify the left-hand side (LHS) of the equation as the percentage change in the number of main lines per 1,000 inhabitants between the end of the previous period and the end of the current period ($\Delta MLINESPT_{it}$). The right-hand side (RHS) variables in the core specification are ln $MLINESPT_{it-1}$, $INLVL_{it-1}$, ln $GDPPC_{it-1}$, $\Delta URBANPOP_{it-1}$, $PUBOP_{it-1}$, *and* $MOBOP_{it-1}$. They are all lagged one period to reflect the fact that changes in sector performance are expected to show up at least one year after changing the RHS variable values. The RHS also includes a year dummy variable in order to capture sample-wide temporal effects, such as a "learning effect" for the regulator. Now that the general model specification is given, I thoroughly describe one by one each RHS variable in order of appearance.

ln $MLINESPT_{it-1}$:

The variable ln $MLINESPT_{it-1}$ represents the existing level of infrastructure penetration, measured as the natural logarithm of main lines per 1,000 inhabitants at the end of the previous period. It appears both alone and as part of a multiplicative interaction term. The coefficient in this variable measures the extent to which the existing level of infrastructure penetration affects penetration growth conditional on all of the other RHS variables. This coefficient represents the "conditional" catch-up effect that I expect to be negative in sign because laggard countries experience higher growth (Henisz *et al.*, 2000).

$INLVL_{it-1}$:

The next variable appearing on the RHS is the measure of the level of regulatory independence. According to our hypothesis, relatively low industry and political pressures on the independence of the regulator should be associated with more rapid rates of penetration growth. I therefore expect the coefficient on the level of regulatory independence to be positive in sign.

$INLVL_{it-1}$ x ln $MLINESPT_{it-1}$:

Next is the interaction term $INLVL_{it-1}$ x ln $MLINESPT_{it-1}$. Since the variable $INLVL_{it-1}$ reflects the extent to which the regulator is perceived by investors as a credible safeguard against hold-up, I include an interaction term in which the existing level of infrastructure penetration ln $MLINESPT_{it-1}$ is multiplied by the level of regulatory independence $INLVL_{it-1}$. The interaction term may allow for the possibility that in the presence of a low penetration level (a small value of ln $MLINESPT_{it-1}$), a high value of $INLVL_{it-1}$ (implied by low industry and political pressures on the independence of the regulator) has a larger effect on penetration growth ($\Delta MLINESPT_{it}$) relative to the size of the effect that it has when the penetration level is high. I expect the estimated coefficient on the interaction term to be negative in sign.

ln $GDPPC_{it-1}$:

The RHS also includes variables to measure determinants of demand. Consistent with the growth theory, the first of these is the natural logarithm of the level of real GDP per capita. Indeed, when the level of demand in a country increases, as well does the level of infrastructure penetration for that country. Consequently, the growth rate of infrastructure penetration should be positively related to the level of real GDP per capita.

$\Delta URBANPOP_{it-1}$:

$\Delta URBANPOP_{it-1}$ is the second determinant of demand that I enclose in the core specification. It represents the percentage growth in the population living in urban areas in each country. In proportion as the country moves from a rural to an urbanized economy, a higher infrastructure penetration is expected because investments are likely to be made in urban zones that offer larger economies of scale and a higher profitability. Therefore, the associated coefficient should be positive.

$PUBOP_{it-1}$:

$PUBOP_{it-1}$ represents the degree of state control in the telecommunications sector (index of state ownership), based on the share of the incumbent operator's capital owned by the state. I assume that when the incumbent operator is still publicly owned, it places the power of enforcement of regulatory functions with the bureaucracy, meaning a potential higher risk for hold-up. Accordingly, I expect the coefficient on this variable to be negative in sign.

$MOBOP_{it-1}$:

$MOBOP_{it-1}$ is the number of mobile cellular operators not owned by the incumbent operator in each country. It is supposed to account for competition in the telecommunications sector. Mobile competitors offer benchmark comparisons of a fixed operator. Moreover, since they are potential threats because they can increase penetration swiftly at relatively lower cost per additional subscriber, a fixed operator is incited to increase penetration to compete with them. Therefore, the sign of the coefficient on this variable should be positive.

YEARDUM:

Despite the general movement towards regulatory reform, the timing and the pattern of change have differed considerably across countries. That is why I introduce a year dummy variable accounting for the patent change generated by regulation and for a potential "learning effect" derived from the experience that the regulator has gained since its creation. The role of the time to creation of the regulator is particularly interesting because it would confirm the effect of experience. For example, the Panama's regulator created in 1993 has 5 years of experience more than its counterpart in Morocco, created in 1998. Yet, this does not rule out the possibility of a rapid "institutional" catch-up for last-mover regulators. Therefore, the variable takes integer values from the year (*year 0*) the regulator is created.

This offers two main advantages:

- first, it allows to distinguish "first-mover" regulators from those created later;
- second, it permits, to some extent, to make up for the low time variability of independence features of the regulator.

Thereby, I expect the coefficient on the year dummy variable to be positive.

Estimation Method

I estimate the coefficients in the model using ordinary least squares with a panel of 30 African and Latin American countries for years 1990-1999. Full equation estimates and tests for model specification can be found in Annex - Table 2.

IV FINDINGS

In this section, I present the regression of the determinants of telecommunications penetration with the equation described in Section III. Then, I carefully interpret results.

IV.1 Regression results

Annex - Table 2 reports the results from estimating the above equation. All of the RHS variables other than the regulatory independence indicator ($INLVL_{t-1}$) have individual t-statistic values significant at 5% or less. The interaction term ($INLVL_{t-1}$ x ln $MLINESPT_{t-1}$) has an individual t-statistic value significant at 15%.

All variables except $INLVL_{t-1}$ show the correct sign. The negative coefficient estimate on ln $MLINESPT_{t-1}$ means that there is a systematic negative association between existing penetration level and penetration growth rate. It confirms the presence of a "catch-up effect". As expected, ln $GDPPC_{it-1}$, $\Delta URBANPOP_{it-1}$, $MOBOP_{it-1}$ and *YEARDUM* are positively correlated with the growth rate of main lines. Indeed, the regression suggests that, *ceteris paribus*, each of them is associated with an increase of 2.59%, 0.96%, 0.72% and 0.77% in the growth rate of main lines. As for $PUBOP_{t-1}$, it is as expected negatively correlated with the explained variable. Indeed, it is associated with a decrease of 0.03%. Unsurprisingly, the interaction term is found to push up the explained variable. Yet, the coefficient on this term is not as strong as expected with respect to the growth rate of infrastructure. Indeed, the coefficient (-0.14) is far lower than the coefficient on the variable ln $MLINESPT_{t-1}$ that is -1.2. This may be due to the effect of the variable $INLVL_{t-1}$ that is more difficult to gauge. Indeed, this variable seems to be significant only when combined with another determinant of the growth rate of main lines. By itself, $INLVL_{t-1}$ shows the wrong sign and significantly worsens the fit of the regression. Indeed, The adjusted R^2 figure is 0.23.

From the results, it seems that the influence of the RHS variables on the growth rate of main lines are confirmed. Yet, the impact of the interaction term is not clear-cut and the proxy of independence is effective only combined with another variable.

IV.2 Interpretation

In this section, I attempt to interpret the unexpected performance of $INLVL_{t-1}$. There may be four main reasons for it.

First, it may be due to a lack of available historical information on the independence characteristics of regulators for a long enough period, leading to a lack of time variability in data. Indeed, on the one hand, the booming of regulators in developing countries is relatively recent, making data collection difficult; on the other hand, even though the performance of regulated markets is sensitive to prevailing economic conditions, regulatory structures are quite impervious to exogenous economic forces as argued by Joskow and Rose (1989). Thereby, regulatory systems tend to respond only to profound changes in the economic and political environment. Also, it can take a lapse of time to translate changes in regulation into changes in infrastructure deployment pattern. This lag between regulatory changes and the actual enforcement of the new regulatory provisions may have been made my dating of regulatory changes inappropriate.

Second, there may be several potential sources of errors in the variables. Indeed, the main lines growth rate indicator may suffer from problems of comparability and interpretation depending on country differences based on geography and the real cost of equipment, such that cross-country growth patterns should be seen as indicative. It is also possible that the explanatory variables are not truly exogenous to performance. For instance, the degree and timing of changes in regulation may be influenced by industry performance.

In this paper, I have implicitly assumed that independent regulation is exogenous to telecommunications penetration performance, but this assumption may be not completely true. Alternatively, performance can influence regulatory independence rather than vice versa. Endogenizing regulation could allow me to separately test these hypotheses. In addition, while independent regulation against hold-up can stimulate performance, it could also be true that improved performance can lead to stimulate regulatory independence, which then have further impacts in a sort of mutual causality process. Indeed, a new regulator, devoid of independence, can establish credibility by exploiting all opportunities it is offered to her to act with transparency, thereby gaining credibility, to step up progressively to full independence. Moreover, regulation and performance may be closely related to each other, possibly because of the influence of omitted variables that are unobservable. To some extent, this problem is lessened by the variable *YEARDUM*.

Third, it is also possible that findings partly depend on the omission of variables expressing changes in the governance structure of the regulator, which may be more relevant than the relatively limited and static concept adopted for independence, which was defined as the combination of regulatory functions and statutory independence. However, this piece of information was not available.

Fourth, my sample of countries may be relatively too small and not random. It implies certainly bias in the empirical analysis.

V CONCLUSION AND FUTURE ISSUES

Based on the insights of the political economy of regulation and on the hold-up theory, I have intended to prove that a country in which industry and political pressures on independence of the regulator are relatively low should show relatively a more rapid growth rate of basic telecommunications infrastructure deployment. I proposed to establish such a link by using data on 30 African and Latin American regulators and telecommunications markets during the period 1990-1999.

On the whole, the pooled estimates suggest that independent regulation does matter in having a relative positive impact on the growth rate of telecommunications penetration. Yet, a large fraction of the variance of the telecommunications penetration variable remains to be explained, meaning that the set of explanatory variables used in the regression could be refined and extended. Therefore, further research is needed to quantify more precisely the actual impact of regulatory independence on performance.

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Table 1
Description and source of variables

Explained variable	Description and source
MLINESPT:	
Main telephone lines per 1000 inhabitants	Number of telephone lines connecting the subscriber's terminal equipment to the public switched network and which have a dedicated port in the telephone exchange equipment divided by the population and multiplied by 1000. Sources: *Year Book of Statistics – Telecommunications Services 1990 – 1999, International Telecommunications Union (ITU), World Development Indicators 2000 (WDI).*
Explanatory variables	**Description and source**
STATIN:	
Independence of TRA from the incumbent operator	Dummy variable indicating whether the country has a separate TRA independent from the incumbent operator. Source: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000.*
Independence of TRA from the sector ministry	Dummy variable indicating whether the country has a separate TRA independent from the sector ministry. Source: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000.*
FUNCIN:	
License Concession	Dummy variable indicating whether the TRA issues license to operators and controls requirements. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search.*
Regulation on Tariffs	Dummy variable indicating whether the TRA approves the detailed tariffs of the incumbent operator. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search..*
Inter-Connection Agreement	Dummy variable indicating whether the TRA approves the interconnection agreements between operators. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search..*
Disputes Arbitration	Dummy variable indicating whether the TRA arbitrates disputes between operators. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search..*
Quality of Service	Dummy variable indicating whether the TRA controls quality of services. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search..*
Numbering	Dummy variable indicating whether the TRA defines and manages the numbering plan. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; National Regulatory Authorities Worldwide, Espicom, 2001, and author's search..*

NB: TRA = Telecommunications Regulatory Authority

Table 1 (Continued)
Description and source of variables

Explanatory variables	Description and source
GDPPC:	
Real Gross Domestic Product per Capita	Gross Domestic Product per capita expressed in constant U.S dollars for the years 1990 - 1999. Source: *World Development Indicators 2000 (WDI).*
URBANPOP:	
Urban Population	Total population living in urban areas within the present boundaries of each country for the years 1990 - 1999. Source: *World Development Indicators 2000 (WDI).*
PUBOP:	
State Control Index	Share of the incumbent operator's capital owned by the state. Sources: *Trends in Telecommunication Reform: Country Profiles, International Telecommunications Union (ITU), 2000 ; websites of incumbent operators, 2001.*
CELLOP:	
Mobile cellular operators	Number of mobile cellular operators not owned by the incumbent operator in each country. Sources: *Mobile Communications, Guide, 1997 ; Centre Français du Commerce Extérieur, 2000.*

Table 2
Results of regression
Infrastructure Deployment and Independence of Regulation

Explained Variable	% change in the number of main lines per 1,000 inhabitants $\Delta MLINESPT_t$			
Period sample	1990 - 1999			
Number of countries	30			
Number of observations	300			
Explanatory Variables	**Coefficient**	**Std. Error**	**t-statistic**	**Probability**
C	-5.930697	5.219806	-1.136191	0.2568
ln $MLINESPT_{t-1}$	-1.208796 [a]	0.882185	-4.627383	0.0000
$INLVL_{t-1}$	-0.093637	0.419238	-0.223350	0.8234
$INLVL_{t-1}$ x ln $MLINESPT_{t-1}$	-0.144440 [b]	0.098243	-1.470234	0.1426
ln $GDPPC_{t-1}$	2.592431 [a]	0.944036	2.746115	0.0064
$\Delta URBANPOP_{t-1}$	0.963976 [a]	0.412268	2.338225	0.0201
$PUBOP_{t-1}$	-0.033379 [a]	0.016033	-2.081927	0.0382
$MOBOP_{t-1}$	0.721891 [a]	0.284862	2.534175	0.0118
YEARDUM	0.773402 [a]	0.222595	3.474474	0.0006
R^2	0.250140			
Adj. R^2	0.239525			

a = significant at 1% level
b = significant at 15% level