# An Empirical Analysis of Competition, Privatization, and Regulation in Africa and Latin America

Scott J. Wallsten*

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Abstract

This paper explores the effects of privatization, competition, and regulation on telecommunications performance in 30 African and Latin American countries from 1984 through 1997. Fixed-effects regressions reveal that competition—measured by mobile operators not owned by the incumbent—is correlated with increases in the per capita number of mainlines, payphones, and connection capacity, and with decreases in the price of local calls. Privatizing an incumbent is negatively correlated with mainline penetration and connection capacity. Privatization combined with an independent regulator, however, is positively correlated with connection capacity and substantially mitigates the negative effect on mainline penetration.

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## 1. Introduction

Since the 1980s, telecommunications markets in developing countries have been undergoing dramatic reforms. Spurred by changes in technology, the abysmal performance of incumbent providers, and prodding by The World Bank and other international organizations, developing countries are privatizing state-owned telecom providers, opening up portions of their telecom markets to competition, and building regulatory institutions. We have a good theoretical understanding of the potential effects of privatization and competition and of the importance of regulation when privatizing a monopoly provider.[1] Our empirical knowledge of their effects in developing countries is much less comprehensive. As Noll (1998) notes, "The main hole in our knowledge about neoliberal reform of telephone service in developing countries is empirical knowledge. . . . As in much of applied microeconomics, the theory to fact ratio is far too high. . . ." Indeed, the empirical work to date consists largely of case studies and non-econometric comparisons of telecom performance before and after privatization.[2] These studies have provided important insights into reform efforts, but we have no econometric tests of the effects of competition, privatization, or regulatory changes. This gap exists largely because reforms in developing countries have occurred relatively recently, meaning that only now is enough data available to begin econometric analysis.

This paper takes a first step at econometric analysis of the effects of reforms. Using an original panel dataset covering 30 countries in Africa and Latin America from 1984 through 1997, the paper explores the effects on telecommunications performance of privatization, competition (as measured by the number of mobile operators in the country not owned by the incumbent), and regulation. I find competition significantly associated with increases in the per capita number of telephone mainlines, number of payphones, connection capacity, and with decreases in the price of a local call. Privatization by itself is significantly associated with decreased mainline penetration and connection capacity, and positively correlated only with payphones. Privatization combined with the existence of a separate regulator, however, is significantly associated with increases in connection capacity and labor efficiency (as measured by employees per mainline), and substantially mitigates the negative correlation with mainlines.

[1] See, for example, Laffont, et al (1997), The Economic Report of the President (1996), Wellenius (1992), Noll (1987).

[2] See Wellenius, et al (1992) for interesting and informative case studies, and Petrazzini (1996) and Megginson (1994) for statistical before-after comparisons.

These findings are broadly consistent with conventional wisdom: competition is the most effective agent of change, privatization without regulation may not improve service, and regulation is especially important when privatizing a monopoly incumbent. One important policy implication of these results is that granting exclusivity periods to an incumbent may seriously delay the real benefits that seem to come with competition.

The paper proceeds as follows. Section 2 briefly discusses the impetus for telecommunication reforms in developing countries, typical components of reform, and the existing empirical literature analyzing the effects of reforms. Section 3 presents the data used in the paper. Section 4 discusses the methodology, and section 5 the results. Section 6 concludes with a discussion.

## 2. Telecommunication reforms

*Impetus for reform*

Most developing countries nationalized telecommunications services in the 1960s. By the late 1980s, however, these countries began to reform their telecom sectors in response to three interrelated factors: the abysmal performance of state-owned telecom providers, changes in technology making less tenable the argument that telecommunications are a natural monopoly, and pressure by The World Bank and other international organizations.

By the 1980s it was clear that nationalized monopoly telecommunications firms in developing countries could not effectively provide telecom services. Wellenius, et al (1992) note that "these state telecommunications monopolies . . . generally fell short of meeting needs, as evidenced by persistent large unmet demand for telephone connections, call traffic congestion, poor service quality and reliability, limited territorial coverage, demonstrated willingness of users to pay far higher prices to obtain service, the virtual absence of modern business services, and user pressures to bypass the system by building their own facilities." In 1981 Africa boasted an average of only 0.8 telephones per hundred people, and Latin America only 5.5, compared to 83.7 in the United States (Saunders, et al 1983). As Noll (1998) points out, "In any nation in which the political structure makes the government even slightly responsive to the interests of its citizens, part of the motivation for policy reform is simply poor performance."

Vigorous competition existed in telecommunications markets around the world in the nineteenth century (Petrazzini 1996). Nonetheless, most countries soon embraced the notion that telecom service was a natural monopoly—that it could be provided at the lowest cost by one firm. Noll (1998) notes that "this belief probably never was accurate, but technology has made it increasingly unlikely." Smith (1997) observes that "telecommunications is now clearly a multiproduct sector with several alternative service delivery mechanisms that permit competition in service provision." Advances in wireless technology alone make it feasible for competing firms to roll out telecommunications services with relatively low sunk costs.

The World Bank has been involved in telecommunications since the 1960s. "Initially, the Bank focused on financing investments to modernize and expand physical plant. . . . In the 1970s, broader efforts were made to strengthen the telecommunications enterprises' organization and management. In the mid-1980s the Bank further expanded the scope of its support for telecommunications, emphasizing sectoral reforms including, where appropriate, the privatization of state telecommunications enterprises" (Wellenius, et al 1992). The increased emphasis on private sector development and on promoting competition by aid agencies as conditions for, and uses of, foreign aid has affected the pace of reform efforts.

*Reforms, predictions, and existing evidence*

Advisers typically recommend three components of telecommunication reform initiatives: privatizing the state-owned monopoly provider, introducing competition, and creating an independent regulatory administration. This description is a gross oversimplification, of course. Each component can be implemented in a variety of ways and to greater or lesser extents. For example, privatization is rarely complete. The government often retains some ownership of the incumbent, at least initially. Competition may be intentionally constrained. The newly-privatized firm may be given an exclusivity period, in which competition (at least in wireline service) is prohibited for a number of years in order to entice investors. Finally, regulation can take many forms, and its details can have large impacts on sector performance and the ability of the incumbent to exercise market power.

In general, there is broad agreement that competition is likely to be the most effective method of promoting improvements in the telecom sector. Wellenius (1992) observes that "A

single monopoly operating enterprise, whether state-owned or private, is increasingly unable to meet equally well the large, varied, and rapidly changing demands of all types of users. Competition, or a credible threat of competition, is likely to spur established operating enterprises to focus attention on customers, improve service, accelerate network expansion, reduce costs, and lower prices." Most agree, also, that while privatization can bring about great improvements, it must be combined with effective regulation. Ambrose, et al (1990) note that "simply moving a monopoly from the public to the private sphere will not result in competitive behavior." Indeed, "private investors, wary of highly politicized processes, have long demanded independent regulators who are removed from government influence. More recently, foreign investors and domestic telecom workers have expressed the same desire" (Petrazzini 1996).

The existing literature contains essentially two types of analyses of reform efforts: case studies and empirical work that compares average performance indicators across firms or countries before and after reforms took effect. Not surprisingly, given the region's relatively early start in reforms, most of this evidence is from Latin America. In general, these studies find positive effects of reforms. On the effects of privatization, Wellenius, et al (1992) conclude from their case studies that

> initial results from privatizing state telecommunications enterprises are generally very encouraging. Governments have successfully sold to consortia led by experienced foreign operating companies capable of providing expert managers, specialized management tools, and continued access to latest technologies. Good financial performance, reflecting both major tariff adjustments and lower costs, is allowing privatized companies to initially finance accelerated investments largely from internally generated funds. Also, international markets have been increasingly willing to provide large amounts of capital for privatized companies in countries with sound macroeconomic and regulatory frameworks (e.g., Chile, Mexico, Argentina).

Megginson, et al (1994) compare pre- and post-privatization financial and operating performance of 61 companies (in 32 industries, including telecommunications) from 18 countries. They find that "after being privatized, firms increase real sales, become more profitable, increase their capital spending, improve their operating efficiency, and increase their work forces."

Petrazzini and Clark (1996) study the effects of competition in Latin America and Asia. Using the existence of cellular firms as evidence of competition, they compare the performance of competitive and noncompetitive markets. They find that cellular and mainline penetration in competitive markets is higher than in noncompetitive markets.

Wellenius, et al (1992) sound a note of caution from their case studies, though. They note that "the single most troubling issue in recent reforms is slow progress in developing regulatory capabilities. . . . Whereas some developing countries have carried out satisfactory privatization in little over one year, the telecommunications regulatory systems are only in their infancy." Galal, et al (1995) adopt a hybrid approach to study the effects of regulatory reforms. They compared the performance of the telecom sector in several countries before and after regulatory reforms. They attempt to explore how well countries were able to balance regulatory objectives: commitment, information asymmetry, and pricing issues. They find that the one country in their sample (Chile) that resolved all three issues achieved the greatest improvement, while the one country (the Philippines) that did not experienced the worst performance. Countries that resolved some issues experienced mixed success.

The existing literature has given us important information on which aspects of telecom reforms seem to succeed and which are more problematic. But this work needs to be complemented by econometric studies that can more rigorously explore the effects of telecom reform. The existing literature cannot, for example, control for other factors that may affect telecom performance. Boubraki and Cosset (1998), in a study of 79 firms (in several industries) in 21 developing countries find significant productivity improvements after privatization. But they also note that "it appears that privatization yields greater benefits for companies headquartered in countries with higher per capita income." This comment highlights the need for econometric analysis—in this case to control for income. While it may be the case that privatization is most successful in wealthier countries, it may also be the case that firms in general in wealthier countries experienced improved productivity during the few years studied. The point here is that it is important to conduct econometric analyses to complement existing work and to begin to address such lingering issues. Enough time has elapsed from the start of reforms to make such analyses possible.

In the remainder of the paper I explore empirically the effects of privatization, competition, and regulatory changes on telecommunications performance. In the following sections I describe the data, methodology, and econometric results.

## 3. Data

The dataset contains information on 30 countries in Africa and Latin America from 1984 – 1997 (Table 1 lists the countries). An observation, therefore, is a country-year. Not all data exist for all countries. Nonetheless, the data allow us to begin exploring empirically the effects of liberalization. Specifically, using this unbalanced panel we can investigate the relationships between competition, privatization, having an independent regulatory agency, and telecommunication performance measures.

Primary telecommunication indicators include the number of main lines, the number of payphones, network connection capacity, telecom employees per main line, and price of a three-minute local call. These statistics come from the International Telecommunications Union (ITU). Table 2 shows trends in these indicators by region (calculated from the countries in the sample).

Main line penetration (main lines per capita, or teledensity) is the most common indicator of telecom performance as it is the variable most commonly reported to the ITU. A main line "is a telephone line connecting the subscriber's terminal equipment to the public switched network and which has a dedicated port in the telephone exchange equipment" (ITU, 1998c). This variable provides an indication of the level of penetration of telephone service in the country. In some ways the number of mainlines per capita overstates access to phones, and in other ways understates it. It may overstate access since some people have several lines—a line at home, as well as two or more at work for phone and fax. It may understate access since some lines will be for public phones or call centers where many people use one line. Nonetheless, it remains the best available indicator of telephone penetration.

The number of payphones per capita provides some measure of the extent of universal service. While this number does not tell us what percentage of the poor or rural population actually has access to a phone, a payphone is, in theory, useful to anyone who lives relatively nearby. Access to a payphone is probably a better indicator of universal service for very impoverished countries than is the percentage of people with telephones in the home.[3]

[3] A good indicator of universal service may be the percentage of the population within walking distance of a public phone.

Connection capacity "corresponds to the maximum number of main lines which can be connected. This number includes, therefore, main lines already connected and main lines available for future connection, including those used for technical operation of the exchange (test numbers). The measure should be the actual capacity of the system rather than the theoretical potential when the system is upgraded or compression technology is employed" (ITU 1998c).

The number of employees per main line provides a measure of labor efficiency. It is not clear what a beneficial effect of reforms would be on this indicator. While we expect privatization and competition to lead to greater efficiency, beneficial reforms could have two, opposite, impacts on this indicator. First, it may induce the incumbent firm to eliminate excess staff (leading to a reduction in staff per main line). Second, it may cause firms to increase employment as they hire staff in order to increase capacity. Thus, the expected results of reforms on this indicator are indeterminate.

The price of a three-minute call is the price "of a peak rate 3-minute call within the same exchange area using the subscriber's own terminal (i.e., not from a public telephone)" (ITU 1998c). Tariff data is the least commonly reported—and least reliable—of these indicators. Again, it is unclear what a beneficial effect of reforms would be on prices. On one hand, competition should work to reduce prices. On the other hand, residential prices are often subsidized. Reforms often include efforts to end cross-subsidies, which could lead to an increase in consumer prices.

This analysis attempts to explore the effects of privatization, competition, and regulation on telecom services, using the variables above to measure service. This reform information comes from ITU publications, Economist Intelligence Unit (EIU) publications, and the U.S. Federal Communications Commission. Privatization is a dummy variable that equals one beginning the year the firm was privatized, if ever. This variable does not capture the extent of privatization; it simply indicates whether the government sold even part of the firm. Competition is measured by the number of wireless operators in the country *not owned* by the incumbent. This is not a perfect measure of competition. For example, cellular service is effectively available only to the wealthy in very poor countries. The most inexpensive cellular plan offered by Telcell (one of three mobile operators) in Ghana, for example, is $25 per month, plus $0.50 per minute after the first ten minutes (Telcell 1999). Even if the user pays only the base charge his bill is $300 per year—quite steep in a country with an average per capita income

of less than $400. Nonetheless, mobile operators offer benchmark comparisons of the incumbent and are potential threats to the incumbent since they can increase penetration swiftly at relatively low cost per additional subscriber. In this capacity they could spur the incumbent to improve its services.

The regulatory measure is a dummy variable indicating whether the country has a separate telecommunications regulatory agency not directly under the control of a ministry. This information comes from ITU publications. Having a separate regulator is generally associated with attempts at regulatory reform, and its effect in a regression analysis is probably better characterized as indicating a country's propensity to undertake regulatory reforms rather than the effect of a separate regulator, per se.

Control variables include per capita income, population, percent of the population living in an urban area, a dummy variable indicating whether the country passed telecom reform legislation, a dummy variable indicating whether a World Bank telecommunications project was active in the country-year, net World Bank aid as a percent of GDP, exports as a share of GDP, and a variable measuring the risk of expropriation. The macroeconomic and demographic variables come from The World Bank's Statistical Information and Management Analysis (SIMA) database. The risk variable comes from the International Country Risk Guide (ICRG), and is 10 point scale where 10 indicates the lowest risk of expropriation.[4]

## 4. Methodology

I use these data to explore the effects of telecom reforms on telecommunication performance. Because countries differ in so many ways I employ a fixed-effects model to control for unobserved country-specific factors. I also include year dummies to control for time trends. I first estimate equation (1) to get a first look at the effects of competition, privatization, and regulation.

$$(1)\quad y_{it} = \alpha_i + \gamma + \beta_1(\text{cell}_{it}) + \beta_2(\text{private}_{it}) + \delta(\text{Reg}_{it}) + \theta(X_{it}) + \varepsilon_{it}$$

[4] The ICRG variable goes only through 1995. Because this variable exhibits little variation over time, I assume that it remains the same from 1995 through 1997. This assumption clearly adds error and may slightly bias coefficients on this variable when used in a regression.

I estimate this equation five times, using as the dependent variable the different telecom indicators discussed above. The five different definitions of the dependent variable, $y_{it}$, are: number of mainlines per capita, number of payphones per capita, network connection capacity per capita, employees per mainline, and the cost of a three-minute call. $Cell_{it}$ is the number of mobile operators not owned by the incumbent and $private_{it}$ is a dummy variable indicating whether the incumbent is privatized. $Reg_{it}$ is the dummy variable measuring whether there exists a separate regulator. $X_{it}$ is a vector of control variables described above.

The regulatory dummy variable does not come close to capturing the many aspects of regulation that can affect telecom performance. This simple variable, however, can provide us with information beyond that derived from estimating equation (1). Theory suggests that simply privatizing a monopoly may not generate telecom improvements. Careful regulation is required to encourage a monopoly to improve its performance. To explore further the effects of regulation I interact the regulation dummy with the privatization dummy and with the number of competitors, and estimate equation (2).

$$(2)\quad y_{it} = a_i + g_t + b_1(\text{cell}_{it}) + b_2(\text{private}_{it}) + b_3(\text{cell}_{it} * \text{reg}_{it}) + b_4(\text{private}_{it} * \text{reg}_{it}) + d(\text{Reg}_{it}) + q(X_{it}) + e_{it}$$

Equation (2) allows us to explore separately the effects of competition, privatization, regulation, and how they interact. That is, how do competition and regulation together, and privatization and regulation together correlate with telecommunication sector performance? This is an especially important question given that theory suggests, and most policy makers and advisers agree, that reforms must give careful thought to regulation when privatizing the monopoly provider.

## 5. Results

This section presents the results of estimating equations (1) and (2) above. The section is organized by telecom indicator. For each indicator I first discuss the results of equation (1) and then of equation (2). The final subsection is an overview and summary of the results. To preview, the results are, in general, consistent with conventional wisdom. Competition is associated with increased mainline penetration, payphones, connection capacity, and lower prices for local calls. Privatization by itself, meanwhile, is significantly associated with an

increase in payphone penetration, but no other benefits. Indeed, alone privatization is correlated with decreases in mainline penetration and connection capacity. Privatization combined with the presence of a separate regulator, however, is associated with increased payphone penetration, connection capacity and increased labor efficiency as measured by employees per main line. Regulation interacted with competition had no significant impact.

*Number of mainlines*

Table 3 shows the results of estimations using number of mainlines as the dependent variables. Column (1) shows results of equation (1). The number of competitors is positively correlated with main lines. Indeed, this regression suggests that, *ceteris paribus*, each mobile competitor is associated with an increase of almost 0.2 additional main lines per hundred population. Privatization turns out to be significantly correlated with a decrease of almost 0.7 main lines per hundred population. Column (2) of Table 3 shows the results of estimating equation (2). The number of competitors remains positive and significant. The regulation dummy is insignificant, as is the competition-regulation interaction coefficient.

The story is different for privatization, however. In column (2) the coefficient on privatization is negative and significant, while the coefficient on privatization interacted with regulation is positive and significant. These results suggest that privatizing the incumbent with no changes in regulatory laws is correlated with a decrease of 1.5 main lines per hundred population. Establishing a separate regulator along with privatizing the incumbent mitigates this effect, however. The coefficient on the interaction term suggests that the combination effect is correlated with a net decrease of about 0.2 lines per hundred population.

As expected, income per capita is strongly positively correlated with main lines per capita. Population and the percentage of population that lives in an urban area are negatively correlated with main lines per capita. Aid—both as a percentage of GDP and the presence of a World Bank telecom project—are insignificant. Exports as a share of GDP is weakly positive, and lower expropriation risk is positively correlated with mainlines per capita.

The variable indicating the passage of reform legislation is negative and significant. The most likely explanation for this result is reverse causality—poor performance helps stimulate reform efforts. Legislation, of course, is necessary before competition and privatization can be

pursued. As the EIU (1997) notes, telecom reform "often requires changes in telecommunications laws or national constitutions, and is subject to legislative and political delays. Once the formal regulatory structures have been implemented, additional time and experience is needed to develop policymakers who understand how new technologies and services impact their markets."

*Payphones*

Table 4 shows the results of equations (1) and (2) using the number of payphones per million as the dependent variable. Column (1) shows results with no interaction terms. As with number of main lines, competition is significantly and positively correlated with additional payphones. Each mobile competitor is associated with almost 54 additional payphones per million population. Privatization is correlated with approximately 264 additional payphones per million. Column (2) shows the results when interaction terms are included. Again, competition is positive and significant. Competition interacted with regulation is not significant. Privatization is negative and significant. Privatization interacted with regulation, however, is positive and significant and of a relatively large magnitude. Regulation alone is significantly negative. These results suggest that privatizing the incumbent combined with the existence of a separate regulator are correlated with a net increase of almost 650 payphones per million population. Privatization without a separate regulator, in column (2), is associated with a decrease of almost 220 payphones per million population. The first mobile competitor is correlated with a net decrease of just over 40 payphones per million, but each additional mobile operator is associated with an increase of 98 per million.

Other results are similar in sign to Table 3 (although often not significant), with a few exceptions. Income per capita and the passage of reform legislation have the same effects as in table 3. Population, however, is positively correlated with the number of payphones per capita. The other controls are not statistically significant.

*Connection capacity*

Table 5 shows the results of equations (1) and (2) using connection capacity as the dependent variable. These results are almost identical to those using mainline penetration. This is not surprising since the number of mainlines is largely determined by connection capacity. Column (1) shows results with no interaction terms. Again, competition is significantly correlated with increased capacity and privatization with decreased capacity. Column (2) shows results when including interaction terms. Competition is positive and significant, while competition interacted with regulation is insignificant. The regulation variable alone, however, is negative and significant. Privatization alone is negative and significant, while privatization interacted with regulation is correlated with a small positive number.

*Labor efficiency—number of employees per main line*

Table 6 shows the results of equations (1) and (2) using the number of employees per mainline as the dependent variable. Column (1) shows results with no interaction terms. The number of mobile competitors is positively correlated with number of employees per main line. Each mobile competitor is associated with 0.1 additional employee per hundred mainlines. The coefficient on privatization is insignificant. Competition remains positive and significant when including the interaction terms, although competition interacted with regulation is not significant. The coefficient on privatization interacted with regulation, however, becomes negative and marginally significant.

These results suggest that competition is correlated with an increase in employment per line while privatization along with a separate regulator is correlated with a decrease. An explanation consistent with theory is that competition brings about much new investment, which requires additional workers. A privatized firm subject to price regulation, meanwhile, may face incentives to cut costs, leading it to reduce a bloated workforce.

Income per capita is negatively correlated with employees per main line. This is consistent with casual observation—firms in higher income countries operate more efficiently. The coefficient on World Bank aid as a percent of GDP is also negative and significant. This may reflect the World Bank's focus on plans to make state-owned enterprises more efficient (often through privatization) as conditions for granting loans.

*Price of local calls*

Price data are the least commonly-reported and among the least reliable of telecom indicators. Even if the price reported is accurate, it is not necessarily easily comparable across countries. The size of a local exchange area may differ dramatically. Prices may be set by the government and bear little relation to costs. The are also often subject to extensive cross-subsidies. Nonetheless, it proves interesting to explore how competition, privatization, and regulation affect this price variable. Table 7 shows results of estimating equations (1) and (2) using the price of a three-minute local call as the dependent variable. Note that the sample size in these regressions is relatively small, so the results should be taken with a grain of salt even larger than with the results discussed above.

Competition is negatively correlated with the price of a local call. Each competitor is correlated with a price reduction of about $US 0.01. Privatization is not significantly correlated with prices. The story with the interaction terms is the same. Competition is correlated with the same price reduction, and privatization (by itself and interacted with regulation) is not correlated with price. This result is somewhat surprising. Although competition typically brings about price reductions for normal goods, residential phone service is often subsidized. Telecom reforms often include efforts to eliminate or reduce cross-subsidies. In those circumstances we would expect an increase in prices. Instead, we see a decrease in prices.

## 6. Discussion/Future issues

The empirical results presented here are largely consistent with conventional wisdom. Competition appears to have tangible benefits across the board—on mainline penetration, payphones, connection capacity, and prices. Privatization by itself does not appear to generate many benefits, and is negatively correlated with main line penetration. Privatization combined a separate regulator, however, is correlated with increased connection capacity and payphones per capita. Moreover, this interaction mitigates the negative effects of privatization on mainline penetration. These results suggest that reformers are correct to emphasize regulatory reforms along with privatization, since privatization without attention to regulation may be costly to consumers. Because competition appears to be the most successful agent of change, reformers

should give careful thought to the notion of granting exclusivity periods to their incumbent telecom providers. While temporary monopoly rights undoubtedly raise the value of the incumbent to potential investors, it may delay the arrival of improved services to consumers.

These results are interesting and encouraging, since they suggest that reform efforts are, in general, on the right track. But these results are far from conclusive. A large number of issues remain to be addressed. A first order of business is to gather more detailed regulatory data. Noting that a country is not ignoring the regulation issue—indicated by establishing a separate regulator—is a start, but does not begin to uncover the possible permutations of regulation. It would be useful to know not only what type of regulation the country adopts (price caps versus cost-of-service, for example), but also details on the regulatory agency itself. What is its annual budget? How many employees does it have? Where do the regulators come from? What sort of training and experience do they have? What enforcement powers does the regulatory authority have?

Second, we should conduct firm-level analyses similar to the ones presented here. Country-level data, while interesting, simply loses too much detail in the aggregation. Moreover, country-level analysis relies on telecom indicators from the ITU. While these are the best country-level data available, they do not always capture all telecom activity in the country. Often they contain information on only the incumbent. Firm-level data would give us a much more detailed and accurate view of the effects of privatization, competition, and regulation and the overall telecom market in the country.

Finally, competition, privatization, and regulation must be endogenized in these analyses. In this paper I have implicitly assumed that they are exogenous to telecom performance, but this assumption is almost certainly not be true. The same factors influencing changes in telecom performance may also influence reforms. Alternatively, performance can influence reforms rather than vice-versa. The finding that privatization is negatively correlated with the number of main lines, for example, could arise because countries are more likely to privatize their incumbent telecom provider when service is poor or because privatization without regulation can harm consumers. Endogenizing privatization would allow us to separately test these hypotheses. In addition, while poor performance can stimulate reforms, it could also be true that improved performance can stimulate additional reforms, which then have further impacts. A country may reluctantly allow a private firm to offer cellular service and, upon witnessing quick performance

improvements, decide to grant further concessions and otherwise liberalize its telecom sector. Empirical analyses should take factors like this into account.

This paper has used an original dataset of 30 countries from 1984 through 1997 to explore the effects of privatization, competition, and regulation on telecom sector performance. Using a fixed effects model, I find that competition in the form of mobile operators not owned by the incumbent are correlated with increases in mainline penetration, the number of payphones per capita, and connection capacity per capita, and with decreases in the price of local calls. Privatization by itself does not appear to generate benefits and is negatively correlated with mainline penetration. Privatization combined with the existence of a separate regulator (which indicates that reforms are at least minimally addressing the issue of regulation), however, is correlated with increases in mainlines, payphones, and connection capacity, and decreases in the price of local calls.

The results suggest that reform efforts tend to be concentrated in the right areas: encouraging competition and emphasizing building regulatory capacity when privatizing an incumbent telecom provider. The benefits associated with competition over privatization, however, should cause policy makers to think carefully when granting exclusivity periods to privatized incumbents and, at the very least, should pay careful attention to the regulatory authority. This paper represents the first attempt at econometric analysis of telecom reform efforts in developing countries. This work is merely a first cut at empirical tests, however. As more data become available for conducting econometric tests, we should gain greater insights. Future work should concentrate on improving data on regulation, gathering firm-level data, and endogenizing reform efforts such as competition, privatization, and regulation.

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**Table 1**
**Countries in Telecommunications Database**

| Africa | Latin America |
|---|---|
| Botswana | Argentina |
| Cameroon | Brazil |
| Cote d'Ivoire | Bolivia |
| Ghana | Chile |
| Kenya | Costa Rica |
| Malawi | Colombia |
| Morocco | Dominican Republic |
| Mauritius | Ecuador |
| Mozambique | Guatemala |
| Nigeria | Jamaica |
| Senegal | Mexico |
| Tanzania | Panama |
| Uganda | Paraguay |
| South Africa | Peru |
| Zambia | Uruguay |
| | Venezuela |

**Table 2**
**Telecom Statistics for Latin American and Africa (excluding South Africa)**

| Year | Mainlines per hundred population | | Payphones per hundred population | | Connection capacity per hundred population | | Employees per line | | Price of 3-min local call | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Latin America | Africa | Latin America | Africa | Latin America | Africa | Latin America | Africa | Latin America | Africa |
| 1984 | 4.56 | 0.74 | 0.06 | n/a | 5.83 | 1.16 | 0.03 | 0.08 | n/a | n/a |
| 1985 | 4.95 | 0.82 | 0.06 | 0.01 | 5.77 | 1.11 | 0.03 | 0.07 | n/a | n/a |
| 1986 | 5.22 | 0.88 | 0.07 | 0.01 | 5.92 | 1.46 | 0.02 | 0.07 | 0.03 | 0.16 |
| 1987 | 5.54 | 0.94 | 0.08 | 0.01 | 6.85 | 1.48 | 0.02 | 0.07 | 0.05 | 0.11 |
| 1988 | 5.86 | 1.00 | 0.09 | 0.01 | 7.61 | 1.29 | 0.02 | 0.07 | 0.06 | 0.11 |
| 1989 | 6.16 | 1.08 | 0.09 | 0.01 | 7.16 | 1.58 | 0.02 | 0.06 | 0.06 | 0.09 |
| 1990 | 6.66 | 1.17 | 0.09 | 0.01 | 8.23 | 1.55 | 0.02 | 0.06 | 0.05 | 0.07 |
| 1991 | 7.14 | 1.30 | 0.09 | 0.01 | 8.54 | 1.86 | 0.02 | 0.05 | 0.05 | 0.06 |
| 1992 | 7.77 | 1.48 | 0.10 | 0.01 | 9.17 | 1.97 | 0.02 | 0.05 | 0.04 | 0.09 |
| 1993 | 8.50 | 1.72 | 0.11 | 0.01 | 10.07 | 2.26 | 0.02 | 0.05 | 0.05 | 0.09 |
| 1994 | 9.19 | 1.95 | 0.12 | 0.01 | 10.78 | 2.40 | 0.01 | 0.04 | 0.05 | 0.07 |
| 1995 | 9.91 | 2.15 | 0.14 | 0.02 | 12.47 | 2.66 | 0.01 | 0.04 | 0.05 | 0.08 |
| 1996 | 10.86 | 2.45 | 0.15 | 0.03 | 13.49 | 3.36 | 0.01 | 0.04 | 0.07 | 0.09 |
| 1997 | 11.67 | 2.94 | 0.18 | 0.05 | 15.34 | 4.14 | 0.01 | 0.03 | 0.07 | 0.06 |

**TABLE 3**
**Effect on mainlines**
**Fixed Effects estimation**

| Dependent variable | Mainlines per hundred population | | | |
|---|---|---|---|---|
| Mean of dependent variable | 4.45 | | | |
| | Column 1 | | Column 2 | |
| | **Coefficient** | **t-statistic** | **Coefficient** | **t-statistic** |
| # mobile operators | 0.18 | 2.81 | 0.25 | 2.71 |
| Incumbent privatized? | -0.69 | -2.32 | -1.45 | -3.21 |
| privatized*separate regulator | | | 1.24 | 2.30 |
| # mobile firms * separate regulator | | | -0.08 | -0.62 |
| Separate regulator | 0.23 | 0.99 | 0.03 | 0.10 |
| Reform legislation passed | -1.06 | -5.35 | -0.97 | -4.84 |
| Population | -0.10 | -4.60 | -0.10 | -4.57 |
| Percent population urban | -0.08 | -3.23 | -0.08 | -3.13 |
| Income per capita | 0.0013 | 13.57 | 0.0014 | 13.85 |
| World Bank telecom project | 0.20 | 1.23 | 0.23 | 1.37 |
| World Bank aid / GDP | -0.27 | -0.10 | 0.23 | 0.08 |
| Exports / GDP | 1.56 | 1.64 | 1.72 | 1.81 |
| Expropriation risk | 0.21 | 3.00 | 0.20 | 2.87 |
| R-squared | 0.96 | | 0.96 | |
| Number observations | 410 | | 410 | |

**TABLE 4**
**Effect on payphones**
**Fixed Effects estimation**

| Dependent variable | Payphones per million population | | | |
|---|---|---|---|---|
| Mean of dependent variable | 816.3 | | | |
| | Column 1 | | Column 2 | |
| | **Coefficient** | **t-statistic** | **Coefficient** | **t-statistic** |
| # mobile operators | 53.55 | 2.98 | 98.10 | 4.28 |
| Incumbent privatized? | 264.26 | 3.01 | -219.96 | -1.95 |
| privatized*separate regulator | | | 867.69 | 6.39 |
| # mobile firms * separate regulator | | | -47.12 | -1.56 |
| Separate regulator | 55.92 | 0.81 | -141.16 | -1.81 |
| Reform legislation passed | -100.88 | -1.73 | -17.94 | -0.33 |
| Population | 53.04 | 7.35 | 51.32 | 7.73 |
| Percent population urban | -2.22 | -0.23 | 0.96 | 0.11 |
| Income per capita | 0.09 | 3.02 | 0.11 | 4.08 |
| World Bank telecom project | -48.21 | -0.81 | -24.24 | -0.43 |
| World Bank aid / GDP | 1718.24 | 0.90 | 2394.74 | 1.37 |
| Exports / GDP | 203.00 | 0.63 | 238.63 | 0.80 |
| Expropriation risk | -17.33 | -0.66 | -12.37 | -0.51 |
| R-squared | 0.92 | | 0.94 | |
| Number observations | 285 | | 285 | |

**TABLE 5**
**Effect on connection capacity**
**Fixed Effects estimation**

| Dependent variable | connection capacity per hundred population | | | |
|---|---|---|---|---|
| Mean of dependent variable | 5.29857 | | | |
| | Column 1 | | Column 2 | |
| | **Coefficient** | **t-statistic** | **Coefficient** | **t-statistic** |
| # mobile operators | 0.26 | 3.23 | 0.23 | 2.19 |
| Incumbent privatized? | -0.72 | -1.93 | -1.48 | -2.80 |
| privatized*separate regulator | | | 1.57 | 2.41 |
| # mobile firms * separate regulator | | | 0.20 | 1.23 |
| Separate regulator | 0.47 | 1.63 | -0.12 | -0.36 |
| Reform legislation passed | -0.83 | -3.34 | -0.71 | -2.86 |
| Population | -0.12 | -4.03 | -0.10 | -3.69 |
| Percent population urban | -0.08 | -2.46 | -0.08 | -2.42 |
| Income per capita | 0.00 | 12.55 | 0.00 | 13.09 |
| World Bank telecom project | -0.03 | -0.14 | 0.04 | 0.18 |
| World Bank aid / GDP | 2.72 | 0.80 | 4.24 | 1.26 |
| Exports / GDP | 1.04 | 0.91 | 1.41 | 1.25 |
| Expropriation risk | 0.08 | 0.87 | 0.06 | 0.62 |
| R-squared | 0.96 | | 0.97 | |
| Number observations | 348 | | 348 | |

**TABLE 6**
**Effect on employees per mainline**
**Fixed Effects estimation**

| Dependent variable | employees per hundred main lines | | | |
|---|---|---|---|---|
| Mean of dependent variable | 1.5115 | | | |
| | Column 1 | | Column 2 | |
| | **Coefficient** | **t-statistic** | **Coefficient** | **t-statistic** |
| # mobile operators | 0.09 | 3.36 | 0.09 | 2.42 |
| Incumbent privatized? | -0.06 | -0.51 | 0.15 | 0.80 |
| privatized*separate regulator | | | -0.35 | -1.62 |
| # mobile firms * separate regulator | | | -0.02 | -0.40 |
| Separate regulator | -0.02 | -0.18 | 0.09 | 0.85 |
| Reform legislation passed | -0.17 | -2.07 | -0.21 | -2.50 |
| Population | -0.02 | -2.39 | -0.02 | -2.36 |
| Percent population urban | 0.04 | 3.97 | 0.04 | 3.92 |
| Income per capita | 0.00 | -7.29 | 0.00 | -7.55 |
| World Bank telecom project | -0.05 | -0.72 | -0.07 | -1.00 |
| World Bank aid / GDP | -1.80 | -1.63 | -2.09 | -1.88 |
| Exports / GDP | 0.66 | 1.69 | 0.63 | 1.61 |
| Expropriation risk | 0.05 | 1.73 | 0.05 | 1.80 |
| R-squared | 0.98 | | 0.98 | |
| Number observations | 394 | | 394 | |

**TABLE 7**
**Effect on the price of a local call**
**Fixed Effects estimation**

| Dependent variable | price of a 3-minute local call | | | |
|---|---|---|---|---|
| Mean of dependent variable | 0.072 | | | |
| | Column 1 | | Column 2 | |
| | **Coefficient** | **t-statistic** | **Coefficient** | **t-statistic** |
| # mobile operators | -0.0090 | -2.58 | -0.0095 | -2.00 |
| Incumbent privatized? | -0.0192 | -0.89 | -0.0075 | -0.27 |
| privatized*separate regulator | | | -0.0200 | -0.75 |
| # mobile firms * separate regulator | | | 0.0000 | 0.01 |
| Separate regulator | 0.0130 | 1.14 | 0.0184 | 1.37 |
| Reform legislation passed | 0.0083 | 0.76 | 0.0044 | 0.36 |
| Population | 0.0054 | 1.99 | 0.0055 | 2.01 |
| Percent population urban | -0.0040 | -1.77 | -0.0042 | -1.83 |
| Income per capita | 0.0000 | 1.05 | 0.0000 | 1.12 |
| World Bank telecom project | 0.0298 | 2.23 | 0.0281 | 2.03 |
| World Bank aid / GDP | -0.0193 | -0.06 | -0.0692 | -0.21 |
| Exports / GDP | -0.1655 | -1.90 | -0.1599 | -1.82 |
| Expropriation risk | 0.0054 | 0.96 | 0.0056 | 1.00 |
| R-squared | 0.76 | | 0.76 | |
| Number observations | 168 | | 168 | |