Impact of privatization in telecommunications - A worldwide comparative analysis[*]

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Abstract

We highlight worldwide differences in the impact of privatization of the telecommunications sector on networks expansion, tariffs, and labor efficiency. Our analysis of a 1985-2008 database on 108 countries shows that privatization had a positive and significant effect on some of these outcome variables in OECD and African resource scarce coastal countries, a positive but weak effect in Latin American and Caribbean countries, and a negative and significant effect in African resource rich and African resource scarce landlocked countries. The idea of a unique model of infrastructure sectors reform that is equally applicable across regions and countries is thus challenged.

JEL-codes: L51, L96, L98, C23.

Keywords: Privatization, Telecommunications, OECD countries, Latin America, Africa.

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1 Introduction

Since the 80s, the telecommunications sector has been largely shaped by a set of market reforms which have been applied worldwide. These reforms have included the liberalization of the telecommunications sector, in particular, the opening to competition of the fixed and cellular segments of the industry often coupled with the privatization of the fixed-line incumbent operator. These changes have been typically accompanied by the creation of regulatory agencies independent from the political administration in a sector where regulation and competition policy have been playing an increasingly important role in the functioning of markets.

Building over more than two decades of experience, the outcome of privatization across different regions raises an important question: Should this reform apply equally to countries at different stages of development in the telecommunications sector and in the overall economy? Arguably, the success of privatization is contingent upon private investors' perception of local conditions. For example, investors face divergent incentives in OECD countries characterized by excess supply and in non-OECD countries where excess demand is rather the norm.

Various factors influence private investors' decision to enter the telecommunications market in a given country. Relevant determinants of investment priorities are wealth, population distribution, geographical location, political accountability, country risk, and status of the telecommunications sector in the country. An overall examination of the various regions of the planet through these lens reveals that there are systematic differences among them along these dimensions. The OECD countries appear as the the most attractive locations, followed by Latin American and Caribbean countries, and subsequently by African countries. Among African countries, resource-scarce landlocked economies obtain by large the worst ranking in the investors' preference scale.

In this paper, we perform an empirical analysis of the impact of privatization of fixed-line operators on network growth, tariffs, and efficiency with the purpose of highlighting important differences among OECD countries, Latin American and Caribbean countries, African resource rich countries, African resource scarce coastal countries, and African resource scarce land-

locked countries. The main motivation for this work is to bring some new insights to the debate on the impact of privatization of fixed-line operators on the development of the telecommunications sector.

The empirical literature has produced divergent results on the impact of privatization of fixed-line networks. We attempt to explain this divergence by the fact that studies use either disaggregated data on a specific country or region, or highly aggregated data such as worldwide data sets. In this study, we use comparable data sets on a large number of countries which allows us to recover most of the results in the literature and beyond. The main policy implication is that privatization yields outcomes that are to a large extent sector-dependent and remain strongly affected by the specific conditions of the country where it is applied.

The plan of the paper is as follows. The next section summarizes some of the empirical results recently put forward in the literature on the impact of the privatization of fixed-line operators on telecommunications outcomes. This section is not meant to be exhaustive but rather to serve the purpose of arguing that there is a need to analyze the impact of privatization in a more disaggregated manner and across a sufficiently large number of countries and regions. Section 3 describes our data and discusses the results of a preliminary analysis of their main properties by means of simple statistics. Section 4 presents and discusses the results of a more thorough econometric analysis of the data. Section 5 summarizes the findings of this study and discusses some policy implications. The appendix provides some complementary technical material.

2   Related literature

The availability of data accumulated over more than two decades on the telecommunications sector has enabled the emergence of a relatively large empirical literature that analyzes the impact of major market reforms on infrastructure deployment in this sector. We briefly review some representative studies with a special focus on the privatization reform and indicate the contribution of our paper to this stream of literature.

Most of the studies on the impact of sectoral reforms on infrastructure

deployment in non-OECD countries acknowledge that overall there exists a robust relationship between some variables representing the reforms and some variables measuring telecommunications network expansion such as fixed-line penetration. In particular, the bulk of this literature has come to the conclusion that the introduction of competition has resulted in measurable improvements in network deployment and labor efficiency in the fixed-line segment. See McNary (2001), Fink et al. (2002), Wallsten (2001), Gutierrez (2003), Ros (1999, 2003), and Li and Xu (2004) among others.

No such a consensus however exists on the impact of the privatization of the fixed-line traditional operator on network expansion. Some empirical studies suggests that this policy has a positive impact on fixed-line technology deployment. After controlling for tariff re-balancing, Banerjee and Ros (2000) find that privatization reduces unmet demand by approximately 28% in a data set on 23 Latin American countries for the period 1986-1995. Gutierrez (2003) reports a reduction of unmet demand of the order of 10 to 18% in data on 22 Latin American countries covering the period 1980-1997. Similar results are obtained with large data sets by Fink et al. (2002), Ros (2003), and Li and Xu (2004). Fink et al (2002) provide an analysis of the impact of privatization of the fixed-line traditional operator on fixed-line deployment and labor efficiency in data on 86 developing countries across African, Asian, Middle Eastern, Latin American and Caribbean countries for the period 1985-1999. Ros (2003) and Li and Xu (2004) use Latin American and worldwide data, respectively.

Other empirical studies have used worldwide data sets, in particular, Ros (1999) and McNary (2001) and have found that privatization has a no or even a negative impact on fixed-line service deployment.[1] Nevertheless, both authors insist on the role played by (independent) regulation in the privatization process, a feature that neither of them include in the analysis. The importance of this matter is further highlighted by Wallsten (2001) and Gutierrez (2003) who find that privatization coupled with the existence of an independent regulator results in larger gains in terms of network expansion. Fink et al. (2002) and Ros (2003) also find that the impact of privatization and competition reforms is enhanced by the creation of a separate regula-

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[1]For an analysis of privatization policies across the world, see Bortolotti and Siniscalco (2004).

tor. As to the impact of privatization on efficiency, evidence suggests that it is similarly affected by the presence of an independent regulator (Wallsten, 2001 and Gutierrez, 2003).[2]

In this study, we seek to contribute to the debate on the impact of the privatization of the fixed-line operator on telecommunications outcomes by performing an econometric analysis that attempts to explain the divergent results found in the empirical literature. The conjecture that our analysis seeks to test is that the different results obtained in the literature on the performance of privatization of fixed-line operators can be explained to a large extent by cross-regional heterogeneity. We trust that privatization should yield different outcomes in OECD and non-OECD countries where the former are characterized by excess supply of telecommunications services and the latter by excess demand. Non-OECD countries are also largely heterogenous in the factors characterizing their telecommunications sector and their economies as a whole.[3]

There are also significant differences among African countries. African resource rich countries engage to a lesser extent in market reforms than other countries in Africa. They can rely on natural resources for their development and hold a stronger independence from policies advocated by International Financial Institutions. In contrast, African resource scarce coastal economies contribute to the trade flows of some commodities and services and are therefore likely to adopt international practices. African resource scarce landlocked countries are those that are worst-off in Africa. These countries' economies are characterized by a lack of natural resources, geographical isolation from international trade flows, and strong dependence on coastal neighbors' policies, in particular, when it comes to the building and maintenance of regional infrastructure networks. Different countries hence offer different incentives to private investors.

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[2]There is also evidence that some other aspects of the privatization process play an important role in network deployment. For example, see Wallsten (2000) and Li and Xu (2004) for the effects of exclusivity periods, and Ros (2003) for the effects of the price cap regulatory regime.

[3]When privatization reforms started, African countries' networks were extremely small relative to those of Latin American and Caribbean countries. Thus, attracting private investment was likely to be more difficult for African countries.

3 Data

We have constructed a time-series-cross-sectional (TSCS) data set containing time-varying information on 108 countries for the period 1985-2008. Our panel includes countries that have reformed their telecommunications sector and countries that have not during the period covered by our data set.[4] We have classified the sample of countries into 23 OECD countries and 85 non-OECD countries. In the non-OECD group we have included 23 countries from Latin America and the Caribbean, 43 from Africa, 6 from the Middle East, and 11 from Asia and the Pacific. These countries are listed below.

- 23 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, The United Kingdom, The United States.

- 25 Latin American and Caribbean countries: Argentina, Bahamas, Barbados, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Nicaragua, Panama, Paraguay, Peru, Suriname, Uruguay, Venezuela.

- 43 African countries: Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Democratic Republic of Congo, Egypt, Republic of Congo, Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritius, Morocco, Mozambique, Namibia, Niger, Nigeria, Senegal, Seychelles, Sierra Leone, South Africa, Swaziland, Tanzania, Togo, Tunisia, Uganda, Zambia, Zimbabwe.

- 6 Middle-Eastern countries: Jordan, Lebanon, Oman, Saudi Arabia, Syria, United Arab Emirates.

- 11 Asian and Pacific countries: Bangladesh, Cambodia, China, India,

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[4]Selectivity bias should therefore not be a concern in our data set.

Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand, Vietnam.

To further discriminate among African countries according to their economic resources and geographical characteristics, we have classified these countries into 15 resource-rich countries, 16 resource-scarce coastal countries, and 12 resource-scarce landlocked countries as shown below.

- 15 resource-rich countries: Algeria, Angola, Botswana, Cameroon, Equatorial Guinea, Gabon, Guinea, Liberia, Namibia, Nigeria, Republic of Congo, Sierra Leone, Swaziland, Tunisia, Zambia.

- 16 resource-scarce coastal countries: Benin, Cap Verde, Egypt, Gambia, Ghana, Ivory Coast, Kenya, Madagascar, Mauritius, Morocco, Mozambique, Senegal, Seychelles, South Africa, Tanzania, Togo.

- 12 resource-scarce landlocked countries: Burkina Faso, Burundi, Central African Republic, Chad, Democratic Republic of Congo, Ethiopia, Lesotho, Malawi, Mali, Niger, Uganda, Zimbabwe.

Data on these countries have been organized in variables regrouped into five categories, namely, "Telecommunications outcomes," "Tele-communications reforms," "Political and risk indices," and "Other variables." The precise definition of each of these variables, the data sources and some standard summary statistics are given in the appendix. Table 1 below lists the acronyms used for these variables and indicates their designation. The next paragraphs discuss their content.

Telecommunications outcomes are measured by the level of output (mainline penetration, cellular subscription), efficiency (mainlines per employee), price (fixed residential, cellular). Telecommunications reforms are represented by variables that give the number of competitors in the analogue and digital cellular segments, a variable that indicates whether a separate telecommunications regulator has been created, and a variable that measures whether some percentage of the fixed-line incumbent's assets have been sold to private investors.[5]

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[5]We do not include competition in the local segment of the fixed-line market. Even though this segment has historically constituted a bottleneck, Gasmi and Recuero Virto

Table 1 - Variables and designation*

Variable	Designation
TELECOMMUNICATIONS OUTCOMES	
ml	Mainline penetration
cel	Cellular subscription
eff	Mainlines per employee
p_res	Monthly subscription to fixed
p_cel	Price of cellular
TELECOMMUNICATIONS REFORMS	
$comp\_cel$	Competition in cellular
reg	Creation of a regulatory agency
$priva$	Privatization
POLITICAL AND RISK INDICES	
$demo$	Democratic accountability
p_risk	Political risk
f_risk	Financial risk
e_risk	Economic risk
OTHER VARIABLES	
gdp	GDP per capita
$rural$	Rural population
$dummy\_rr$	Africa resource rich
$dummy\_rsc$	Africa resource scarce coastal
$dummy\_rsl$	Africa resource scarce landlocked

$^{(*)}$A detailed description of these variables and their sources is provided in the appendix.

The political and risk indices indicate the degree of accountability in the government as well as political, financial, and economic risk valuations that are relevant to investment choices and ultimately to sector outcomes. We also include some other variables that measure some demand and supply factors that are deemed relevant for our estimation of the impact of privatization. Those are GDP per capita, the percentage of the total population that is rural, and some dummy variables that identify African countries that are resource rich, resource scarce coastal, and resource scarce landlocked.

We next explore some properties of the data contained in these variables on the basis of some simple descriptive statistics. Tables A1-A7 of the appendix give some summary statistics on these variables for each of the regions in our sample. A close look at these tables suggests that the regions can

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(2009) do not find a significant correlation between its opening to competition and the outcome variables considered here.

be classified according to some explanatory variables that measure wealth, population distribution, political accountability, risk, and the status of the telecommunications sector. Both OECD and Latin American and Caribbean countries are characterized by having a high percentage of the population in urban areas, namely, respectively 74.8% and 61.4%. Otherwise, OECD countries are outperforming their Latin America and Caribbean counterparts in the level of GDP per capita, the economic and financial risks, the degree of democratic accountability, and the openness of the telecommunications sector as measured by the creation of independent regulators and the degree of competition in the cellular market.

African countries are systematically outperformed by Latin American and Caribbean countries. If we disaggregate further, African resource rich and resource scarce coastal countries share similar characteristics in terms of the level of GDP per capita, the share of population living in urban areas (around 40%), and the economic and financial risks. African resource scarce coastal countries perform nevertheless better in the political risks and the degree of democratic accountability and show higher liberalization trends in the telecommunications sector.

African resource scarce landlocked countries differ substantially from the rest of the countries in our sample with a level of GDP per capita that falls to less than a quarter of the African average, a share of rural population that attains 80%, the worst indicators in financial, economic, and political risks as well as the lowest degree of democratic accountability. These countries have nevertheless a more liberalized telecommunications sector than resource rich countries.

These features of the data are also discussed in Bates et al. (2008) who indicate that African resource scarce landlocked countries are particularly prone to state breakdown with the government being unable to maintain internal security. These countries are also the most exposed in Africa to anti-growth syndromes. On the other hand, the telecommunications sector is more liberalized in resource scarce coastal than in resource scarce landlocked countries since the returns to market-oriented policies are higher in the former (Gallup et al., 1999).

Table 2 below synthesizes the most relevant information by giving the averages over the period under study of the main variables of interest to us, namely, privatization of the fixed-line incumbent ($priva$), mainline penetration (ml), cellular subscription (cel), mainlines per employee (eff), monthly subscription to fixed (p_res), and price of cellular (p_cel). In OECD countries, 60% of the fixed-line operators are at least partly privatized, twice as much as in non-OECD countries. The levels of telecommunications outcomes in terms of deployment and labor efficiency are largely above those of non-OECD countries as well. Prices of fixed-line and cellular are also above those of non-OECD countries.

Table 2 - Privatization and telecom outcomes variables regional averages

Region	$priva$	ml	cel	eff	p_res	p_cel
OECD	0.6	49.9	35.3	181.8	19.9	1.3
Non-OECD	0.3	6.1	7.6	66.7	8.2	0.8
Latin America & Caribbean	0.4	11.4	11.0	102.7	8.4	1.1
Africa	0.3	2.5	4.8	40.6	8.3	0.8
-Resource rich	0.3	2.2	5.5	40.1	6.5	0.8
-Resource scarce coastal	0.3	4.3	6.9	51.1	7.9	0.7
-Resource scarce landlocked	0.1	0.51	1.2	25.9	10.4	0.9

Concerning non-OECD countries, Latin America and the Caribbean, African resource rich and African resource scarce coastal countries have privatized between 30 and 40 percent of the fixed-line operators. This number falls to 10% in African resource scarce landlocked countries. Regarding outcomes, Latin America and the Caribbean countries are ahead of their African counterparts in fixed-line and cellular deployment, and in labor efficiency. In particular, they perform in these measures twice as better as African resource rich and African resource scarce coastal countries, and over four times better than African resource scarce landlocked countries.

Table 3 below presents the correlation coefficients between our main variable of interest, namely, privatization of the fixed-line operator, and the variables reflecting telecommunications outcomes. We clearly see that this correlation is the strongest between privatization and cellular deployment suggesting the existence of complementarities between the fixed-line and cellular segments of the industry. Also, the correlation is generally quite strong between privatization and labor efficiency in the fixed-line. The correlation

between privatization and fixed-line prices and fixed-line deployment is not as strong. A noticeable (positive) correlation is the one between privatization and fixed-line prices for Latin American and the Caribbean and African resource rich countries, and the one between privatization and fixed-line deployment for African resource rich countries. The positive albeit weak correlation between privatization and fixed-line prices is consistent with tariffs re-balancing that usually accompanies privatization reforms in a sector historically characterized by urban to rural and international and long distance to local service cross-subsidies. The correlation is the weakest between privatization and cellular prices although systematically negative across regions due to competition pressure.

Table 3 - Correlations*

Region	ml	cel	eff	p_res	p_cel
OECD	0.08	0.48	0.30	0.07	-0.21
Non-OECD	0.19	0.25	0.20	0.10	-0.03
Latin America and Caribbean	0.08	0.19	0.18	0.22	-0.03
Africa	0.26	0.35	0.30	0.05	-0.12
-Resource rich	0.48	0.35	0.45	0.42	-0.17
-Resource scarce coastal	0.12	0.30	0.11	0.10	-0.04
-Resource scarce landlocked	0.08	0.33	0.22	0.07	-0.13

[*] Correlation coefficients between privatization and telecom outcomes variables.

This preliminary analysis of the data sets the ground for a scrutiny of the relationship between the privatization reform and telecommunications outcomes in the samples on OECD and non-OECD countries. A first checkup of the data by means of variable averages suggested to consider separately the the countries from different regions. We then searched in the data for evidence of a relationship between the privatization reform and telecommunications outcomes by means of correlation coefficients. Such a relationship was found to exist, in particular, for cellular deployment and labor efficiency in the fixed-line. We also find that the correlation between privatization and outcomes is particularly strong for African resource rich countries. We now turn to a further exploration of this relationship through an econometric analysis of our data sets.

4   Econometric analysis

To investigate the impact of the privatization reform on telecommunications outcomes, we run a set of regressions with the dependent variable representing a measure of service deployment, prices, or efficiency. The explanatory variables have been chosen to allow us to estimate the impact of privatization while controlling for other features that may have played an important role in the determination of the outcomes in the telecommunications sector.

Given that our data have a time-series-cross-sectional (TSCS) structure, we choose to apply fixed-effect and random-effect models. Fixed-effect models allow us to control for fixed unobserved heterogeneity and are therefore preferred to random models when estimating the relationship between privatization and telecommunications outcomes.[6] Time dummies are included when the model's goodness-of-fit improves with the presence of these variables.[7]

We specify the following model:

$$y_{it} = \alpha_0 + \mathrm{x}'_{it}\beta + \epsilon_{it} \tag{1}$$

where $i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$ are indices that refer to a country and a year respectively, y_{it} is a one-dimensional variable representing the continuous dependent variable, namely, fixed-line deployment, cellular deployment, labor efficiency, price of fixed-line, or cellular service, α_0 is a scalar parameter, x_{it} is a vector of regressors, β is the associated vector of parameters, and ϵ_{it} is a disturbance term. The vector of regressors x_{it} includes a variable that informs on the privatization of the fixed-line operator and other explanatory variables that indicate the degree of competition in the cellular market, whether or not an independent regulatory agency has been created, the level of political, economic, and financial risks, the degree of democratic accountability, and some variables that measure wealth and population distribution.

In order to account for dynamics in our data, we first specified regres-

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[6]Wald tests applied to our data confirmed the presence of fixed-effects.

[7]Testing for the presence of time-specific effects seems particularly relevant in our context since some important events have occurred during the period under study. These events include, among others, the 1995 "Tequila crisis," the 1997 South-asian crisis, the 1998-1999 financial breakdown, and some events related to technological progress such as the introduction of digital system.

sions that we estimated using the Differenced Generalized Method of Moments (DIF-GMM).[8] However, fixed and random models systematically outperformed these dynamic regressions.[9] To take care of endogeneity problems which seem likely to arise when estimating equation (1), we use a procedure based on DIF-GMM to find appropriate instruments.[10] Endogeneity can be indeed an issue in our context as, for example, the government might raise efficiency prior to engaging in privatization in order to increase the probability of attracting investors. One can also argue that the government might decide to privatize because the fixed-service penetration rate is low. Again, these endogenous regressions were systematically outperformed by fixed-effect and random-effect models.[11]

The estimation results are presented in Tables A10-A17 of the appendix. These tables show the fixed-effect and random-effect estimation results on which we build our testing procedure asking whether the variable of privatization, $priva$, has a significant impact on the variables of telecommunications outcomes, namely, mainline penetration (ml), cellular subscription (cel), mainlines per employee (eff), monthly subscription to fixed (p_res), and price of cellular (p_cel). We also include in our estimations some control variables. Those include telecommunications reforms variables, namely, cellular competition ($comp\_cel$) and the creation of a separate regulator (reg), political and risk indices, namely, democratic accountability ($demo$), political risk (p_risk), financial risk (f_risk), and economic risk (e_risk), and some other variables, namely, rural population ($rural$) and GDP per capita (gdp), and a constant ($const$). The estimates shown in these tables are those of the parameters of equation (1).

The inspection of the simple statistics presented in the previous section has allowed us to identify noticeable differences in, and hence analyze separately, the following regions: OECD (see Tables A8 and A9), non-OECD (see Tables A10 and A11), Latin America and the Caribbean (see Tables A12 and A13), Africa (see Tables A14 and A15), and Africa resource rich, Africa re-

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[8]This method was developed by Arellano and Bover (1995) for analyzing panel data and applied by Beck and Katz (2004) to TSCS data.

[9]Results obtained with DIF-GMM are available from the authors upon request.

[10]For a detailed description of this procedure, see Gasmi et al. (2009).

[11]DIF-GMM results that account for endogeneity are available from the authors upon request.

source scarce coastal, and Africa resource scarce landlocked (see Tables A16 and A17). In addition to showing the estimated values of the parameters associated with the explanatory variables listed in the first column, Tables A8-A17 include three additional items. First, we indicate whether or not time dummies were included in the regression (Time).[12] Second, we provide an F-statistic (F), in the fixed-effects models case, and a Wald statistic ($Wald$), in the random-effects models case, for testing the joint significance of the explanatory variables. Third, we indicate the number of observations (Obs.) used in each regression.

Cross-examining Tables A10-A17, we observe that the results are fairly similar for the fixed and random-effects models. However, the results obtained with the data on OECD countries convey quite different messages than those obtained with the data on non-OECD countries. The impact of privatization of the fixed-line operator in OECD countries is only significant (and positive) when labor efficiency is used as the measure of the telecommunications sector's performance. The finding that privatization does not have a significant impact on fixed-line deployment in OECD countries is consistent with the fact that when this reform was introduced, these countries had already well supplied markets.

In contrast, the impact of privatization on the price of fixed-line service is strongly significant and positive in non-OECD countries. This result reflects the fact that when privatization has been introduced, most of these countries had not yet implemented tariff re-balancing and were still applying cross-subsidization schemes between urban and rural consumers and between international, long distance, and local calls. For instance, prices of fixed-line were historically kept below cost for local communications which were subsidized by long distance and international calls. In the non-OECD countries sample, privatization is found to have a positive effect on cellular deployment although the impact is rather weak. This suggests that there exists some degree of complementarity between the level of privatization of the fixed-line operator and the number of cellular subscribers. Such a relationship may be explained by the fact that parts of the resources from privatization of the fixed service segment were allocated to investment in cellular network. In ad-

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[12]The inclusion of time dummies is done on the basis of the the value of a Wald statistic for testing the joint significance of time-specific effects.

dition, we find that privatization of the fixed-line segment has not translated into a significant increase in fixed-line deployment nor in fixed-line efficiency. Hence, the increase in residential prices of fixed-line in non-OECD countries that followed privatization (and re-balancing) has benefited more the cellular segment (as subscription increased) than the fixed service segment (as there was no effect on penetration or efficiency).

Non-OECD countries are nevertheless strongly heterogenous when analyzed in more details. An examination of the estimation results obtained with the fixed- and random-effect models allows us to conclude that, overall, the impact of privatization of the fixed-line operator in Latin America and the Caribbean is weaker than in Africa. In fact, when fixed-effects models are used, we find that privatization of the fixed-service operator has no significant impact on any of the outcomes telecommunications variables. When we consider the impact of privatization on the fixed service segment efficiency, we see that it is weakly positive in our sample of Latin American countries and strongly negative in our sample of African countries. Another noticeable difference between the results obtained with the Latin American and the Caribbean and African samples is in the impact of privatization on the cellular segment. This impact is weak and negative in Latin America and the Caribbean and strong and positive in Africa. Hence, privatization of the fixed segment has benefited the cellular segment in African countries but not so much in Latin American and Caribbean countries.[13]

There are also some similarities between the results obtained with the samples of countries in the Latin American and the Caribbean and African regions and the most noticeable one is that privatization has resulted in growth of fixed-line penetration rates in neither region. Moreover, in both regions there is a positive relationship between privatization and fixed-line prices and this relationship is is particularly strong in Africa. In addition, neither in Latin American and Caribbean countries, nor in African countries, privatization had a significant impact on prices in the cellular segment. While private operators often justify price increases of fixed-line service to raise investment, increases in residential tariffs in our data set did not translate into larger network deployment.

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[13]African countries seem thus to have relied more than Latin American and Caribbean countries on revenues from privatization to develop their cellular markets.

Comparing the results obtained for African countries when we account for their resource endowments and geographical locations, we see that there are some differences. The impact of privatization of the fixed-line operator on outcomes in the fixed-line sector is strongly negative in our sample of African resource rich and resource scarce landlocked countries and positive in African resource scarce coastal countries. In resource rich countries, privatization strongly and positively affects prices of fixed line service and negatively fixed line penetration and labor efficiency. In resource scarce landlocked countries, privatization resulted in a significant and negative impact on fixed-line labor efficiency. Finally, in resource scarce coastal countries instead, privatization had a positive and significant impact on both prices of the fixed-line operator and labor efficiency. As to the cellular segment it seems that it has substantially benefitted from privatization in African resource rich and resource scarce coastal countries and, in contrary, suffered from it in African resource scarce landlocked countries. In none of the African regions, privatization had a significant impact on prices of cellular.

Tables 4 and 5 below summarize our results. Cross-examining these two tables, we see that privatization has no significant impact on the price of cellular in any of our sub-samples of countries and on fixed service penetration rates in the OECD and non-OECD sub-samples of countries. When we further examine the relationship between privatization and fixed service penetration rates in non-OECD countries, we see that while it is non-significant in Latin American and Caribbean countries, it is strongly negative in African countries. We also see that this negative African effect is driven by its strong significance in African resource rich countries as, indeed, it is not significant at all in the two other groups of countries, African scarce coastal and landlocked countries.

Labor efficiency in the fixed segment is significantly and positively affected by privatization in OECD countries. When analyzing the whole sample of non-OECD, we find that privatization has no impact on labor efficiency. The story is more complex when examining the sub-samples of non-OECD countries. In the Latin American and Caribbean countries, privatization has a weak effect on labor efficiency in the sense that this effect is found significant (at the 5% level) only when the random-effects model is used. In contrast,

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the effect of privatization on labor efficiency is negative in the African countries sample. This is consistent with the finding that privatization has a positive effect on labor efficiency in the African resource scarce coastal sample of countries, but that in the resource rich and resource scarce landlocked countries this effect is negative.

Consistent with the fact that, as discussed above, privatization has no significant impact on fixed service deployment in OECD countries , the results show no impact on the price of the service in these countries as well. The same is true for cellular where privatization is found to have a significant impact neither on service deployment nor, as already mentioned, on service price. In non-OECD countries, thanks to tariffs re-balancing, privatization has been followed by an increase of fixed service residential price. Tracking out this effect further, in non-OECD countries it turns out that it is driven by its high significance (at the 1% level) in African countries as it is not significance at all in Latin American and Caribbean countries in the estimation of the fixed-effects model and significant at the 5% level in that of the random-effects model. Now, examining more carefully African countries, we see that this effect is in fact strong in resource rich countries and less in resource scarce coastal but not significant in resource scarce landlocked.[14] This gives us indications on the extent to which tariff re-balancing policies have been implemented in the various regions.

As already mentioned, we find that privatization has a significant impact on neither price of, nor subscription to, cellular in the sample of OECD countries. In the sample of non-OECD countries, we find that privatization has a moderate impact on cellular subscription in the sense where its coefficient is non-significant in the fixed-effects model and significant at the 10% level in the random-effects model. When we disaggregate this effect of privatization on cellular and examine the Latin America and Caribbean and African sub-samples, we see that it is significant, but negative, in the former only when the random-effects model is used and strongly negative (at the 1% significant level) in the latter when both fixed- and random-effects models are used. This positive effect in Africa is in fact prevalent in the resource rich and resource scarce coastal regions and even negative in the poorest region,

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[14]Consistency between price of residential and fixed service penetration rates.

namely, the resource scarce landlocked part of the continent. This confirms the fact that privatization and tariff re-balancing have made cellular a more attractive means of communications than fixed for African citizens who could afford it.

Table 4 - Impact of privatization on outcomes (Fixed-effects model)[+]

Region	ml	cel	eff	p_res	p_cel
OECD	NS	NS	+*	NS	NS
Non-OECD	NS	NS	NS	+***	NS
Latin America and the Caribbean	NS	NS	NS	NS	NS
Africa	-***	+***	-**	+***	NS
-Resource rich	-***	+***	-***	+*	NS
-Resource scarce coastal	NS	+***	+***	+***	NS
-Resource scarce landlocked	NS	-***	-**	NS	NS

[+]NS: Non-significant; +/-: Positive/negative impact; */**/***: 10%/5%/1% significance level.

Table 5 - Impact of privatization on outcomes (Random-effects model)[+]

Region	ml	cel	eff	p_res	p_cel
OECD	NS	NS	+***	NS	NS
Non-OECD	NS	+*	NS	+***	NS
Latin America and the Caribbean	NS	-*	+**	+**	NS
Africa	-***	+***	-***	+***	NS
-Resource rich	-***	+***	-***	+**	NS
-Resource scarce coastal	NS	+***	+***	+***	NS
-Resource scarce landlocked	NS	-***	-***	NS	NS

[+]NS: Non-significant; +/-: Positive/negative impact; */**/***: 10%/5%/1% significance level.

5 Conclusion

This paper has sought to contribute to the empirical literature on the impact of the privatization of the fixed-line telecommunications operator on sector performance by analyzing the outcomes of this reform in a large set of worldwide experiences during the last three decades. Our work has demonstrated that the divergent results reported in various studies may be explained to a large extent by cross-regional heterogeneity. In particular, our results are remarkably different when considering comparable samples of countries belonging to the OECD, the Latin American and the Caribbean, the African resource rich, the African resource scarce coastal, and the African resource scarce landlocked regions.

The econometric analysis of our data has shown that in the OECD countries privatization has positively affected labor efficiency in the fixed segment but has had no significant impact on any of the other telecommunications outcome variables used during the 1985-2008 period. In the sample of African resource scarce coastal countries, privatization has increased labor efficiency, fixed service prices, and cellular deployment. However, the raises in the fixed service residential prices, following re-balancing of subsidized local service residential tariffs, have not translated into greater fixed service penetration rates.

In the sample comprising the Latin American and Caribbean countries, privatization has been found to have a positive but relatively weak effect on labor efficiency and fixed service prices. In contrast, the impact of privatization is strong and negative in African resource rich and African resource scarce landlocked countries. In the sample of African resource rich countries, privatization has resulted in lower labor efficiency, higher residential prices, and lower service deployment in the fixed segment. In fact, the impact of privatization on the fixed segment has been the worst in these countries. In the sample of African resource scarce landlocked countries, privatization has led to lower labor efficiency in the fixed segment and lower cellular deployment.

Summing up, our empirical analysis has allowed us to uncover the following features from the data. First, because at the time privatization programs have been launched in OECD countries fixed telecommunications service was in excess supply, no significant effects of these programs on network expansion have been found in the data on these countries. Second and unexpectedly, these effects have not been found even in the non-OECD countries where fixed networks are rather scarcely developed. Third, despite the fact that one of the justifications put forward by governments to privatize is to increase productive efficiency, support for this justification is found only in our data on OECD and African resource scarce coastal countries. Finally, residential prices of fixed service increased with privatization mostly in African countries which lagged behind in the implementation of tariffs re-balancing policies.

The results presented in this paper for the case of telecommunications thus challenge the idea that there is unique model of reform for infrastructure

sectors that is equally applicable across regions and countries. As far as privatization reform is concerned, it entails providing incentives for private actors to commit to long-term investment and the empirical results obtained in this paper suggest that sector and economy-wide factors in a country are key factors in attracting capital and that these in turn are important determinants of the success or failure of privatization programs.

<div align="center">**Appendix**</div>

Definition of variables

We have collected data on variables regrouped in five categories: "Telecommunications outcomes," "Telecommunications reforms," "Political and risk indices," and "Other variables." The definition of these variables is given next.

Telecommunications outcomes
- Output
    . Mainline penetration: Number of telephone lines per 100 inhabitants that connect the subscribers' terminal equipment to the Public Switched Telephone Network (PSTN).
    . Cellular subscription: Number of users of portable telephones subscribing to a mobile telephone service with access to the PSTN.

- Efficiency
    . Mainlines per employee: Number of mainlines per employee in the fixed service industry.

- Price
    . Monthly subscription to fixed: Recurring fixed charge (in 2000 US dollars) paid by residential subscribers to the PSTN operator. This charge covers only the line rental and not the terminal rental.
    . Price of cellular: Price (in 2000 US dollars) paid for a 3-minute call during peak hours from a cellular telephone. For reasons of inter-country comparability, this price corresponds to that of a call placed with a prepaid card.

Telecommunications reforms
- Privatization: Dichotomous variable which takes on the value 1 if the assets of the incumbent have been partly (or totally) sold to private investors and 0 if the incumbent is State-owned.
- Competition in cellular: Dichotomous variable with value 1 if there is more than one operator in the cellular segment (analogue or digital) and 0 if this segment is a monopoly.
- Creation of a regulatory agency: Dichotomous variable which takes on the value 1 if a regulatory agency exists and is separated from and not directly controlled by a ministry or a utility and 0 otherwise.

Political and risk indices
- Democratic accountability: This variable taking on values in the range [0-6] is a measure of how responsive the government is to the citizens. The assumption is that the less responsive the government is the more likely it will fall peacefully in a democratic society but possibly violently in a non-democratic one.

- Political risk: Variable which is a composite of 12 variables reflecting political and social factors. The values of this risk index lie in the range [0-100]. Higher values of this index indicate lower risk.
- Financial risk: Variable which is a composite of 5 variables that measure ratios of the national financial structure. Values of this risk index are in the range [0-50]. Higher values indicate lower risk.
- Economic risk: Composite variable that includes 5 variables that measure ratios of the national economic structure. The values of this risk index are in the range [0-50] with higher values corresponding to lower risk.

Other variables

- Rural population: Variable that indicates the percentage of the total population residing in rural areas.
- GDP per capita: Gross Domestic Product per capita measured in 2000 USD.
- Africa resource rich: Dichotomous variable which takes on the value 1 if the country is African resource rich and 0 otherwise.
- Africa resource scarce coastal: Dichotomous variable which takes on the value 1 if the country is African resource scarce coastal and 0 otherwise.
- Africa resource scarce landlocked: Dichotomous variable which takes on the value 1 if the country is African resource scarce landlocked and 0 otherwise.

Data sources

The sources of the data on the variables included in each of the 4 groups of variables are given next.

Telecommunications outcomes	
Variable	Source(s)
OUTPUT	
• Mainline penetration	-ITU*
• Cellular subscription	-ITU
EFFICIENCY	
• Mainlines per employee	-ITU
PRICE	
• Monthly subscription to fixed	-ITU
• Price of cellular	-ITU

(*)International Telecommunications Union.

Telecommunications reforms	
Variable	Source(s)
• Privatization	-Ros (1999, 2003), Bortolotti et al. (2001), McNary (2001), Li and Xu (2004), Fink et al. (2002). -ITU World Telecommunications Regulatory database. -Operators' and regulators' websites. -Clark et al. (2004). -Private Partcipation in Infrastructure (PPI) Project World Bank database. -IPANeT Privatization Transactions database (World Bank).
• Competition in cellular	-Ros (1999, 2003), Bortolotti et al. (2001), McNary (2001), Li and Xu (2004), Fink et al. (2002). -Trends in Telecommunication Reform 1999: Convergence and Regulation, ITU. -ITU World Telecommunications Regulatory database. -Operators' and regulators' websites. -Clark et al. (2004). -http://www.gsmworld.com.
• Creation of a regulatory agency	-Trends in Telecommunication Reform 1999: Convergence and Regulation, ITU. -ITU World Telecommunications Regulatory database.

Political and risk indices	
Variable	Source(s)
• Democratic accountability	-International Country Risk Guide (ICRG) risk ratings
• Political risk	-ICRG risk ratings
• Financial risk	-ICRG risk ratings
• Economic risk	-ICRG risk ratings

	Other variables	
Variable	Source(s)	
• Rural population	-World Bank Indicators (WBI)	
• GDP per capita	-WBI	
• Africa resource rich	-Bates et al. (2008)	
• Africa resource scarce coastal	-Bates et al. (2008)	
• Africa resource scarce landlocked	-Bates et al. (2008)	

Summary statistics

Tables A1-A7 that follow give some summary statistics on each subgroup of countries in the sample.

Table A1 - Summary statistics (OECD countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	528	49.95	10.52	14.52	74.19
cel	Cellular subscription	526	35.35	39.87	0	135.14
eff	Mainlines per employee	486	181.82	67.66	43.48	526.20
p_res	Monthly subscription to fixed	414	14.91	4.58	5.55	26.47
p_cel	Price of cellular	293	1.31	0.76	0.11	5.64
$priva$	Privatization	552	0.57	0.49	0	1
$comp\_cel$	Competition in cellular	552	0.59	0.49	0	1
reg	Creation of a regulatory agency	552	0.53	0.49	0	1
$demo$	Democratic accountability	547	5.71	0.56	3	6
p_risk	Political risk	522	66.09	14.15	29.16	94.41
f_risk	Financial risk	547	41.92	5.11	25.66	50
e_risk	Economic risk	547	39.76	3.50	25.83	48.41
$rural$	Rural population	552	25.20	11.07	2.64	54.70
gdp	GDP per capita	552	23,253.82	8,674.32	6,423.80	56,189.02

Table A2 - Summary statistics (Non-OECD countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	1993	6.08	8.13	0.03	50.14
cel	Cellular subscription	2009	7.64	17.26	0	173.37
eff	Mainlines per employee	1658	66.77	68.39	1.10	564.30
p_res	Monthly subscription to fixed	1322	8.17	11.07	0.23	135.59
p_cel	Price of cellular	843	0.85	1.24	0.12	23.65
$priva$	Privatization	2112	0.30	0.46	0	1
$comp\_cel$	Competition in cellular	2136	0.46	0.49	0	1
reg	Creation of a regulatory agency	2136	0.39	0.48	0	1
$demo$	Democratic accountability	1771	3.23	1.35	0	6
p_risk	Political risk	1770	57.11	12.07	9.58	86.41
f_risk	Financial risk	1770	30.68	8.10	6.5	49
e_risk	Economic risk	1770	31.47	6.44	1.37	48.00
$rural$	Rural population	2127	55.45	21.34	6.68	94.80
gdp	GDP per capita	2076	2,135.67	3,344.51	62.23	29,268.68

Table A3 - Summary statistics (Latin American and Caribbean countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	588	11.43	9.77	0.52	50.14
cel	Cellular subscription	588	11.01	20.13	0	112.89
eff	Mainlines per employee	495	102.74	85.44	13.23	564.30
p_res	Monthly subscription to fixed	365	8.38	12.73	0.23	135.59
p_cel	Price of cellular	242	1.11	1.89	0.02	23.65
$priva$	Privatization	600	0.39	0.48	0	1
$comp\_cel$	Competition in cellular	624	0.44	0.49	0	1
reg	Creation of a regulatory agency	624	0.45	0.49	0	1
$demo$	Democratic accountability	576	3.80	1.29	0	6
p_risk	Political risk	576	60.31	11.94	23.08	86.41
f_risk	Financial risk	576	31.55	7.92	6.5	45.67
e_risk	Economic risk	576	31.20	6.16	1.37	44.04
$rural$	Rural population	624	38.66	17.47	6.68	76.70
gdp	GDP per capita	594	3,488.00	3,262.03	402.01	17,353.78

Table A4 - Summary statistics (African countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	995	2.51	4.61	0.41	28.71
cel	Cellular subscription	1071	4.82	12.69	0	89.22
eff	Mainlines per employee	808	40.62	35.37	3.81	218.71
p_res	Monthly subscription to fixed	679	8.30	11.13	0.25	85.49
p_cel	Price of cellular	395	0.82	0.74	0.04	6.08
$priva$	Privatization	1071	0.26	0.43	0	1
$comp\_cel$	Competition in cellular	1071	0.43	0.49	0	1
reg	Creation of a regulatory agency	1071	0.38	0.48	0	1
$demo$	Democratic accountability	826	2.92	1.17	0	5.5
p_risk	Political risk	826	54.74	11.42	9.83	79.83
f_risk	Financial risk	826	28.79	7.57	9.83	79.83
e_risk	Economic risk	826	30.43	6.67	5.33	45.25
$rural$	Rural population	1071	65.09	15.30	14.96	94.80
gdp	GDP per capita	1065	978.27	1,414.66	62.23	8, 692.03

Table A5 - Summary statistics (African resource rich countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	327	2.24	2.66	0.05	12.46
cel	Cellular subscription	336	5.57	13.72	0	87.85
eff	Mainlines per employee	246	40.06	31.04	3.81	149.10
p_res	Monthly subscription to fixed	209	6.47	8.51	0.25	60.54
p_cel	Price of cellular	117	0.81	0.71	0.04	4.36
$priva$	Privatization	360	0.33	0.47	0	1
$comp\_cel$	Competition in cellular	360	0.37	0.48	0	1
reg	Creation of a regulatory agency	360	0.28	0.45	0	1
$demo$	Democratic accountability	307	2.84	1.10	0	5.5
p_risk	Political risk	307	54.33	13.10	9.83	79.83
f_risk	Financial risk	307	28.76	9.39	8.00	49.00
e_risk	Economic risk	307	32.01	7.31	7.37	45.25
$rural$	Rural population	360	56.92	14.39	14.96	78.20
gdp	GDP per capita	360	1,362.29	1,454.73	62.23	8,692.03

Table A6 - Summary statistics (African resource scarce coastal countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	378	4.27	6.60	0.22	28.71
cel	Cellular subscription	382	6.94	15.50	0	89.22
eff	Mainlines per employee	331	51.14	42.30	6.41	218.71
p_res	Monthly subscription to fixed	247	7.96	11.31	0.27	85.45
p_cel	Price of cellular	145	0.74	0.63	0.08	3.89
$priva$	Privatization	408	0.29	0.45	0	1
$comp\_cel$	Competition in cellular	408	0.52	0.50	0	1
reg	Creation of a regulatory agency	408	0.44	0.49	0	1
$demo$	Democratic accountability	312	3.23	1.16	1	5.5
p_risk	Political risk	311	58.45	8.27	36	74.50
f_risk	Financial risk	311	30.86	5.78	17.87	42.25
e_risk	Economic risk	311	30.50	5.99	5.33	39.54
$rural$	Rural population	399	60.76	11.21	39.26	83.30
gdp	GDP per capita	395	1,216.88	1,679.06	139.92	8,267.39

Table A7 - Summary statistics (African resource scarce landlocked countries)

Variable	Designation	Obs.	Mean	Std. Dev.	Min.	Max.
ml	Mainline penetration	290	0.51	0.55	0.04	2.96
cel	Cellular subscription	296	1.24	3.08	0	22.71
eff	Mainlines per employee	239	25.90	20.34	4.65	178.97
p_res	Monthly subscription to fixed	223	10.41	12.69	0.49	77.85
p_cel	Price of cellular	133	0.93	0.86	0.07	6.08
$priva$	Privatization	312	0.12	0.33	0	1
$comp\_cel$	Competition in cellular	312	0.40	0.49	0	1
reg	Creation of a regulatory agency	312	0.41	0.49	0	1
$demo$	Democratic accountability	216	2.57	1.16	0.66	5
p_risk	Political risk	216	50.30	10.97	21.75	75.00
f_risk	Financial risk	216	25.93	5.66	11.08	40.50
e_risk	Economic risk	216	28.02	5.88	8.16	36.75
$rural$	Rural population	312	80.07	8.87	61.42	94.80
gdp	GDP per capita	309	225.08	128.60	81.00	680.45

Regressions

Tables A8-A17 below exhibit the parameter estimate obtained with the fixed-effect and random-effect models applied to data on each group of countries in the sample.

Table A8 - Fixed-effect regression parameter estimates (OECD countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	3.081***	0.105	5.151***	2.415***	1.469
$priva_{it}$	0.007	-0.022	0.064*	-0.032	-0.029
$comp\_cel_{it}$	0.024	0.180***	0.026	0.093***	-0.121
reg_{it}	0.042***	0.294***	0.066*	0.054*	0.004
$demo_{it}$	0.086***	0.108***	0.034	-0.121***	-0.027
p_risk_{it}	0.002***	0.000	0.011***	-0.000	-0.005
f_risk_{it}	0.002	0.013**	-0.002	-0.009**	-0.005
e_risk_{it}	-0.008***	-0.032***	0.012**	0.005	0.008
$rural_{it}$	-0.001	-0.000	-0.046***	0.023***	0.051
gdp_{it}	0.000***	0.000	-0.000**	0.000**	-0.000***
Time	Yes	Yes	Yes	Yes	No
F	34.67***	541.60***	42.26***	8.86***	16.75***
Obs.	494	492	453	391	276

[(+)]*/**/***: 10%/5%/1% significance level.

Table A9 - Random-effect regression parameter estimates (OECD countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	3.110***	-0.182	4.224***	2.667***	1.743*
$priva_{it}$	0.007	-0.028	0.095***	-0.032	-0.135
$comp\_cel_{it}$	0.023	0.187***	0.043	0.087***	-0.229**
reg_{it}	0.042***	0.293***	0.084**	0.052*	-0.122
$demo_{it}$	0.087***	0.124***	0.037	-0.122***	-0.101
p_risk_{it}	0.002***	0.000	0.011***	-0.000	-0.002
f_risk_{it}	0.002	0.012**	-0.003	-0.008**	0.010
e_risk_{it}	-0.008***	-0.031***	0.006	0.009*	0.005
$rural_{it}$	-0.003	-0.000	-0.010**	0.010*	-0.003
gdp_{it}	0.000***	0.000	0.000	0.000**	-0.000***
Time	Yes	Yes	No	Yes	No
$Wald$	111.97***	16670.20***	328.80***	275.98***	135.86***
Obs.	494	492	453	391	276

[(+)] */**/***: 10%/5%/1% significance level.

Table A10 - Fixed-effect regression parameter estimates

(Non-OECD countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	-0.263	0.681**	1.880***	1.454	-4.442***
$priva_{it}$	0.007	0.054	-0.013	0.372***	-0.141
$comp\_cel_{it}$	0.064*	0.060	0.148***	0.089	-0.234**
reg_{it}	-0.116***	0.096**	-0.093***	0.180***	-0.264**
$demo_{it}$	-0.050***	-0.033**	-0.052***	-0.073***	-0.046
p_risk_{it}	0.001***	0.001	-0.000	0.003	0.002
f_risk_{it}	0.010***	-0.002	0.006**	-0.012**	-0.028***
e_risk_{it}	-0.000***	-0.002	0.000	0.010*	-0.000
$rural_{it}$	-0.001	-0.023***	0.013***	0.019*	-0.097***
gdp_{it}	0.000***	0.001***	0.000***	0.000***	-0.000
Time	Yes	Yes	Yes	Yes	No
F	86.11***	392.73***	98.22***	26.20***	21.03***
Obs.	1601	1606	1342	1086	710

[+] */**/***: 10%/5%/1% significance level.

Table A11 - Random-effect regression parameter estimates

(Non-OECD countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	0.633***	0.324**	3.286***	2.592***	0.705
$priva_{it}$	-0.001	0.068*	-0.023	0.377***	-0.111
$comp\_cel_{it}$	0.062*	0.099**	0.156***	0.045	-0.450***
reg_{it}	-0.108***	0.094**	-0.077**	0.202***	-0.372***
$demo_{it}$	-0.040***	-0.035**	-0.043***	-0.078***	-0.032
p_risk_{it}	0.001	0.007**	-0.000	0.009**	0.007
f_risk_{it}	0.011***	0.000	0.006**	-0.018***	-0.039***
e_risk_{it}	0.001	-0.002	0.002	0.006	-0.001
$rural_{it}$	-0.018***	-0.010***	-0.010***	0.011***	0.036
gdp_{it}	0.000***	0.000***	0.000***	0.000***	0.000
Time	Yes	Yes	Yes	Yes	No
$Wald$	2695.73***	10520.32***	2902.47***	751.12***	142.51***
Obs.	1601	1606	1342	1086	710

[+] */**/***: 10%/5%/1% significance level.

Table A12 - Fixed-effect regression parameter estimates
(Latin American and Caribbean countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	0.852***	-0.812**	1.024**	1.705	1.667
$priva_{it}$	0.043	-0.016	0.001	0.297	-0.327
$comp\_cel_{it}$	0.136***	0.073	0.201***	-0.286*	0.047
reg_{it}	0.073**	0.125**	0.223***	-0.081	0.170
$demo_{it}$	0.009	-0.0320	-0.035	-0.201***	-0.106
p_risk_{it}	0.003	-0.006*	0.009	0.001	0.008
f_risk_{it}	0.004**	-0.009**	-0.000**	-0.033***	-0.012
e_risk_{it}	-0.000	-0.001	0.009*	-0.004	-0.001
$rural_{it}$	0.032***	-0.015*	0.087***	0.023	-0.134***
gdp_{it}	-0.611**	0.000***	0.000	0.000***	0.000***
Time	Yes	Yes	Yes	No	Yes
F	108.34***	365.80***	48.94***	8.35***	12.73***
Obs.	498	497	423	318	217

[+] */**/*** indicates significance at the 10%/5%/1% level.

Table A13 - Random-effect regression parameter estimates
(Latin American and Caribbean countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	0.672	0.262	3.150***	3.411***	-1.181
$priva_{it}$	0.014	-0.094*	0.130**	0.336**	-0.144
$comp\_cel_{it}$	0.075**	0.086	0.328**	-0.421***	-0.231
reg_{it}	0.083**	0.114*	0.124	-0.019	-0.082
$demo_{it}$	0.017	-0.039	0.089**	-0.165**	-0.191***
p_risk_{it}	0.004**	0.003	0.021***	0.006	0.043***
f_risk_{it}	0.002	-0.015***	-0.016**	-0.042***	-0.017
e_risk_{it}	0.005*	0.007*	0.022***	0.000	-0.001
$rural_{it}$	-0.004	-0.006**	-0.020***	-0.001	-0.009*
gdp_{it}	0.000***	0.000***	-0.000***	0.000	0.000
Time	Yes	Yes	Yes	No	Yes
$Wald$	2590.59	10264.91***	753.72***	72.79***	243.42***
Obs.	498	497	423	318	217

[+] */**/*** indicates significance at the 10%/5%/1% level.

Table A14 - Fixed-effect regression parameter estimates (African countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	-0.265	1.865***	2.383***	0.838	-6.099**
$priva_{it}$	-0.118***	0.198***	-0.121**	0.413***	0.209
$comp\_cel_{it}$	-0.027	0.143***	0.078*	0.095	-0.119
reg_{it}	0.114***	0.152***	0.031	0.098	-0.447***
$demo_{it}$	0.017	-0.090***	-0.010	-0.067**	0.038
p_risk_{it}	-0.003	0.000	-0.006***	0.001	-0.007
f_risk_{it}	0.003***	0.002	0.008**	-0.018**	-0.016
e_risk_{it}	0.000	-0.001	-0.001	0.015**	0.002
$rural_{it}$	-0.011**	-0.029***	0.002	0.028	0.102***
gdp_{it}	0.000***	0.001***	0.000***	0.000***	0.000
Time	Yes	Yes	Yes	Yes	No
F	33.40***	173.77***	39.58***	18.32***	9.82***
Obs.	764	774	626	529	312

(+) */**/***: 10%/5%/1% significance level.

Table A15 - Random-effect regression parameter estimates (African countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	-0.265	0.254	2.501***	0.747	-0.299
$priva_{it}$	-0.119***	0.236***	-0.113**	0.430***	0.096
$comp\_cel_{it}$	-0.022	0.135**	0.083*	0.070	-0.273**
reg_{it}	0.113**	0.156***	0.034	0.131	-0.505***
$demo_{it}$	0.020	-0.089***	-0.014	-0.080**	0.016
p_risk_{it}	-0.003	0.004*	-0.005**	0.004	-0.003
f_risk_{it}	0.004	0.006	0.010***	-0.018**	-0.025
e_risk_{it}	0.001	-0.004	-0.001	0.014**	0.006
$rural_{it}$	-0.014***	-0.005***	0.000	0.028***	0.014*
gdp_{it}	0.000***	0.000***	0.000***	0.000**	0.000
Time	Yes	Yes	Yes	Yes	No
$Wald$	1083.36***	5182.54***	1232.24***	532.27***	72.00***
Obs.	764	774	626	529	312

(+) */**/***: 10%/5%/1% significance level.

Table A16 - Fixed-effect regression parameter estimates
(Subgroups of African countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	0.062	1.177**	1.913***	0.144	-6.595**
$priva_{it} * dummy\_rsc$	0.027	0.364***	0.219***	0.261*	0.339
$priva_{it} * dummy\_rsc$	0.027	0.364***	0.219***	0.790***	0.207
$priva_{it} * dummy\_rsl$	-0.066	-0.342***	-0.686**	0.094	0.007
$comp\_cel_{it}$	-0.037	0.135**	0.051	0.104	-0.115
reg_{it}	0.087**	0.188***	0.063	0.100	-0.416***
$demo_{it}$	0.015	-0.085***	0.000	-0.067**	0.016
p_risk_{it}	-0.004**	0.001	-0.008***	0.002	-0.007
f_risk_{it}	0.006**	0.002	0.012***	-0.014*	-0.015
e_risk_{it}	-0.000	-0.002	-0.002	0.013**	0.002
$rural_{it}$	-0.014***	-0.020***	0.008	0.037**	0.109***
gdp_{it}	0.000***	0.000***	0.000***	0.000***	0.000
Time	Yes	Yes	Yes	Yes	No
F	32.59***	171.69***	43.66***	17.98***	8.06***
Obs.	764	774	626	529	312

[(+)]*/**/***: 10%/5%/1% significance level.

Table A17 - Random-effect regression parameter estimates
(Subgroups of African countries)[+]

Variable	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$	$log(p\_res_{it})$	$log(p\_cel_{it})$
$const$	0.032	-0.078	2.077***	0.277	-0.334
$priva_{it} * dummy\_rr$	-0.308***	0.268***	-0.272***	0.257**	0.162
$priva_{it} * dummy\_rsc$	0.029	0.415***	0.219***	0.796***	0.057
$priva_{it} * dummy\_rsl$	-0.067	-0.352***	-0.686***	0.104	0.072
$comp\_cel_{it}$	-0.033	0.127**	0.056	0.080	-0.270**
reg_{it}	0.086*	0.156***	0.069	0.119	-0.505***
$demo_{it}$	0.017	-0.078***	-0.003	-0.077**	0.017
p_risk_{it}	-0.004*	0.003	-0.007***	0.004	-0.003
f_risk_{it}	0.007**	0.006*	0.013***	-0.014**	-0.026**
e_risk_{it}	0.000	-0.004	-0.002	0.012*	0.006
$rural_{it}$	-0.016***	-0.001	0.006	0.033***	0.015*
gdp_{it}	0.000***	0.000***	0.000***	0.000***	0.000
Time	Yes	Yes	Yes	Yes	No
$Wald$	1125.58***	5462.79***	1459.11***	566.71***	72.65***
Obs.	764	774	626	529	312

[(+)] */**/***: 10%/5%/1% significance level.

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