Empirical evidence on the impact of privatization of fixed-line operators on telecommunications performance - Comparing OECD, Latin American, and African countries*

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Abstract

The aim of this paper is to highlight empirically some important worldwide differences in the impact of privatization of the fixed-line telecommunications operator on network expansion, tariffs, and efficiency during the 1985-2007 period for a large panel of countries. Our work suggests that the divergent results in the empirical literature on the performance of the privatization reform can be explained to a large extent by cross-regional heterogeneity. We find that the impact of privatization on outcomes is significantly positive in OECD and African resource scarce coastal countries, weakly positive in Latin American and the Caribbean countries, and strongly negative in African resource rich and African resource scarce landlocked countries. The results presented in this paper thus challenge the idea that there is a unique model of reform for infrastructure sectors that is equally applicable across regions and countries.

JEL-codes: L51, L96, L98, C23
Keywords: Privatization, Telecommunications

February 2011

*Corresponding author: farid.gasmi@tse-fr.eu. The analysis presented in this paper is based on a database that covers the period 1985-2008 and is an extension of some work that contributed to the 2009 OECD-AfDB-UNECA *African Economic Outlook* (AEO) on "Innovation and Information and Communication Technology in Africa." The authors thank the editors of the 2009 AEO for comments on the preliminary work that was based on a 1985-1999 data sample. The authors also thank participants to The World Bank-PPIAF-IDEI-AFD *International Conference on Infrastructure Economics and Development*, Toulouse, January 14-15, 2010 for useful comments. Special thanks to J. Stern. All remaining errors are ours. The views expressed in this paper reflect only the opinions of the authors and not necessarily those of their institutions.

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 included the liberalization of the telecommunications sector, namely the opening to competition of fixed and cellular segments often coupled with the privatization of the fixed-line traditional operator. These changes were typically accompanied by the creation of regulatory agencies independent from political power in a sector where regulation and competition policy were playing an increasingly important role in the functioning of the market.

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 on 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 was the norm.

Various factors influence private investors' decision to enter the market. Relevant determinants of investment priorities are measures of wealth, population distribution, geographical location, political accountability and risk, as well as the status of the telecommunications sector. Through these lens, there are systematic differences between regions, OECD countries being 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 scores.

In this research, 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 any important differences when examining OECD countries, Latin American and Caribbean countries, African resource rich countries, African resource scarce coastal countries and African resource scarce landlocked 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 telecommunications sector.

The empirical literature has produced divergent results on the outcome

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 very aggregated data (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. The main policy implication is that the outcomes of a privatization reform are to a large extent sector-dependent and remain strongly affected by the specific country-conditions 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 the basic econometric ingredients that constitute the elements of the empirical methodology we use to analyze the data sets on 23 OECD countries and 85 non-OECD countries covering the period 1985-2007. In section 4, we discuss the results of a preliminary analysis of these data and of the fixed-effect and random-effect estimations of the impact of privatization. Section 5 summarizes our empirical findings and discusses some policy implications. A detailed description of the data used, their sources, data statistics and estimations are given in the appendix.

2 The impact of privatization - What do we know?

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 in this stream of literature with a special focus on the privatization reform and indicate the contribution of our paper.

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 on 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).

There is no such a consensus on the impact of the privatization of the fixed-line traditional operator on network expansion. Some empirical results indicate that this policy has a positive impact on fixed-line 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 by Fink et al. (2002), Ros (2003), and Li and Xu (2004) using large data sets.[1]

However, other empirical studies using worldwide data sets, in particular Ros (1999) and McNary (2001), indicate that privatization has a null or even a negative impact on fixed-line deployment.[2] Nevertheless, both authors insist on the role played in the privatization process by regulators independent from political power, feature that neither of them include in their analyses. The importance of this matter is 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 regulator. As to the impact of privatization on efficiency, evidence suggests that it is sim-

[1]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.

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

ilarly affected by the presence of an independent regulator (Wallsten, 2001 and Gutierrez, 2003).[3]

In this study, we seek to contribute to the debate on the impact of the privatization of the fixed-line operator on telecommunications outcomes with an econometric analysis that attempts to explain the divergent results in the empirical literature. Our analysis tests the conjecture that the different results in the literature on the performance of privatization of fixed-line operators can be explained to a large extent by cross-regional heterogeneity.

The privatization reform 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. For example, when privatization reforms started African networks were extremely small, lagging behind their counterparts in Latin America and the Caribbean. Attracting private investment was likely to be more difficult for African countries.

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 (IFIs). 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 the lack of natural resources, the geographical isolation from international trade flows and the strong dependence on coastal neighbors' policies, particularly when it comes to the building and maintenance of regional infrastructure networks. Different countries offer hence different incentives to private investors.

[3]There is evidence that some details of the private transactions also play an important role on network deployment. 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 Data and econometric specification

In this section, we first describe the data set on 108 countries that we constructed and the basic ingredients of the econometric methodology used to analyze them.

3.1 Data

We have constructed a time-series-cross-sectional (TSCS) data set containing time-varying information on 108 countries for the period 1985-2007.[4] These data have been organized in variables regrouped in five categories, namely, "telecommunications outcomes," "telecommunications reforms," "political and risk indices," and "other variables." The list of the countries included in the data set, the definition of each of the variables, the data sources and some standard summary statistics are given in the appendix.

We classify the sample in 23 OECD countries and 85 non-OECD countries. In the non-OECD group we include 23 countries from Latin America and the Caribbean, 43 from Africa, 6 from Middle East and 11 from Asia and the Pacific. In the African sample we further classify countries according to their resources and geographical characteristics with 15 resource rich, 16 resource scarce coastal and 13 resource scarce landlocked (see Table A1 in the appendix).

Telecommunications outcomes are measured by the level of output (mainline penetration or cellular subscription), efficiency (mainlines per employee), or price (fixed residential, cellular). Telecommunications reforms are represented by variables that give the number of competitors in the analogue and digital cellular segments, 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]

The political and risk indices indicate the degree of accountability in the government, as well as political, financial and economic risk valuations

[4]Our panel includes countries that have reformed their telecommunications sector and countries that have not. Hence, selectivity bias should not be a concern in our data set.

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

that are relevant to investment choices and ultimately to sector outcomes. Variables under the heading of "other variables" are those that measure some demand and supply factors that are deemed relevant for our estimation of the impact of privatization such as the Gross Domestic Product (GDP) per capita and the percentage of rural population. Under this classification, we also include dummy variables that identify African as resource rich, resource scarce coastal and resource scarce landlocked.

3.2 Econometric model

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 deployment, prices or efficiency. The explanatory variables have been chosen to allow us to test the impact of privatization, while controlling for other features that may have played a major role in the determination of the outcomes in the telecommunications sector.

Given the type of our data which are TSCS, we choose to apply fixed-effect and random-effect models. Fixed-effect models allow 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 $i = 1, 2, \ldots, N$, $t = 1, 2, \ldots, T$, y_{it} is a one-dimensional variable representing the continuous dependent variable (fixed-line deployment, cellular deployment, labor efficiency, price of fixed-line and price cellular), 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. x_{it} includes the privatization of

[6]Indeed, Wald tests confirm 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.

the fixed-line operator, but also other explanatory variables such as the degree of competition in the cellular market, the creation of an independent regulator, political, economic and financial risks, the degree of democratic accountability and measures of wealth and population distribution.

In order to account for dynamics in our data, we make use of the Differenced Generalized Method of Moments (DIF-GMM) developed by Arellano and Bover (1995) for analyzing panel data and applied by Beck and Katz (2004) to TSCS data. However, fixed and random models systematically outperform these dynamic regressions.[8]

To take care of endogeneity problems which seem likely to arise in the estimation of equation (1), we set a procedure to find appropriate instruments using the DIF-GMM (see Gasmi et al., 2009). Endogeneity can be indeed an issue in our context. For example, the government might raise efficiency prior to engaging in privatization to increase the probability of attracting investors. One can also argue that the government might decide to privatize because the number of fixed-lines is extremely low. However, these endogenous regressions were systematically outperformed by fixed-effect and random-effect models.[9]

4 Impact of privatization

4.1 Preliminary analysis

In this section we explore some basic statistics of our data set. First, we compare across regions the statistics on explanatory and dependent variables from Tables A2-A8 in the appendix. The most relevant information is summarized in Table 1 below. Then, we analyze the correlations between the privatization variable and those variables capturing telecommunications outcomes.

By taking a close look at Tables A2-A8 in the appendix, we can see that regions can 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

[8]Results are available from the authors upon request.

[9]Results are available from the authors upon request.

and Caribbean countries are characterized by having a high percentage of the population in urban areas (74.8% and 61.4%, respectively). 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.

Africa 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 data are consistent with Bates et al. (2008) where 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).

In Table 1 below, we can see the average over the period under study of the variables of interest to us, namely, privatization of the fixed-line incumbent($priva$) and telecommunications outcomes: 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,

Table 1
Privatization and outcomes

	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

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.

Concerning non-OECD countries, Latin America and the Caribbean, African resource rich and African resource scarce coastal countries have privatized between 30-40% 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.

In Table A9, we can see the correlation coefficients between privatization

of the fixed-line operator and the variables capturing telecommunications outcomes. This correlation is the strongest between privatization and cellular deployment, which suggests complementarities between fixed-line and cellular sectors. The correlation is also very strong and positive between privatization and labor efficiency in the fixed-line.

The relationship between privatization and fixed-line prices and fixed-line deployment is not very strong. In particular, there exists a positive correlation between privatization and fixed-line prices for Latin American and the Caribbean and African resource rich countries, and between privatization and fixed-line deployment for African resource rich countries. The positive (although weak) correlation between privatization and fixed-line prices is consistent with the re-balancing of tariffs that usually accompanies this reform in a sector characterized by urban vs rural and international and long vs local distance cross-subsidies in calls. The correlation is the weakest between privatization and cellular prices although it is systematically negative for all regions due to the competition pressure.

The 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. This light-handed checkup of the data has led us to conclude that there are reasons to identify different regions. The next step then has been to search in the data for evidence of a relationship between the privatization reform and telecommunications outcomes by means of correlation tests. These tests have also shown that such a relationship might exist and that it is stronger 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.

4.2 Regression results

In this section, we address the existence of relationships between the privatization of the fixed-line and the telecommunications outcomes by running a set of regressions. Tables A10-A19 in the appendix 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, 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), 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).

In line with the inspection of simple statistics in the preliminary analysis, we identify the following regions for our analysis: OECD (Tables A10-A11), non-OECD (Tables A12-A13), Latin America and the Caribbean (Tables A14-A15), Africa (Tables A16-A17) and Africa resource rich, Africa resource scarce coastal and Africa resource scarce landlocked (Tables A18-A19).

In addition to showing the estimated values of the parameters associated with the explanatory variables listed at the left, Tables A10-A19 include three additional items. Firstly, we show whether time dummies are included or not in the regression under Time.[10] Secondly, we provide an F-statistic (F) for fixed-effects or Wald statistic ($Wald$) for random-effects for testing the joint significance of the explanatory variables. Thirdly, we include the number of observations included in each regression (Obs.).

In Tables 2 and 3 below, we can see the results of the estimations in Tables A10-A19 summarized for the relationships of interest. By comparing these two tables, we see that results are fairly similar for the fixed and random-effects models. The least one can say about the results obtained with the data on OECD countries is that they do not convey the same messages as non-OECD countries. The impact of privatization of the fixed-line operator in OECD countries is only significantly (and positively) correlated with labor efficiency in the fixed-line. The non significant impact of privatization on fixed-line deployment is consistent with the fact that when this reform was introduced in OECD countries, they had already well supplied markets.

In non-OECD countries the impact of privatization is instead strongly

[10]The inclusion of time dummies is done consistently with the value of a Wald statistic for testing the joint significance of time-specific effects.

Table 2
Impact of privatization on outcomes: Fixed-effects

Privatization	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
Africa resource rich	- (***)	+ (***)	- (***)	+ (*)	NS
Africa resource scarce coastal	NS	+ (***)	+ (***)	+ (***)	NS
Africa resource scarce landlocked	NS	- (***)	- (**)	NS	NS

Note: NS stands for non-significant. + and - reflects that the impact is significant and the sign. */**/*** stands for significance at the 10%/5%/1%.

and positively correlated with the price of fixed-line. This is consistent with the fact that when privatization started in these countries, most had not implemented tariff re-balancing and were still working under 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 non-OECD countries privatization is also positively correlated with cellular deployment, though to the impact is weak. This suggests some degree of complementarity between privatization of the fixed-line operator and the number of cellular subscribers. In Tables 1 and 2 however, we can see that privatization of the fixed-line 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 with the arrival of

Table 3
Impact of privatization on outcomes: Random-effects

Privatization	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
Africa resource rich	- (***)	+ (***)	- (***)	+ (**)	NS
Africa resource scarce coastal	NS	+ (***)	+ (***)	+ (***)	NS
Africa resource scarce landlocked	NS	- (***)	- (***)	NS	NS

Note: NS stands for non-significant. + and - reflects that the impact is significant and the sign. */**/*** stands for significance at the 10%/5%/1%.

privatization have not resulted into larger penetration or efficiency in the fixed-line.

Non-OECD countries are nevertheless strongly heterogenous when analyzed more in detail. From a joint look at the fixed and random-effect estimation results, we can derive the following conclusions for Latin American and the Caribbean and African regions. The impact of privatization in Latin American and the Caribbean countries is weaker than in Africa. Indeed, none of the privatization variables are significant in the fixed-effect estimations of Latin America and the Caribbean as we can see in Table 1.

The results also suggest that the impact of privatization of the fixed-line operator on outcomes in the fixed-line sector are strongly negative in our sample of African countries while weakly positive in Latin American and the Caribbean countries. Indeed, with the data on African countries privatization of the fixed-line operator is strongly and negatively correlated with fixed-line deployment and labor efficiency. Instead, with the data on

Latin American and the Caribbean countries there is a weak and positive relationship between privatization and fixed-line labor efficiency.

Another difference between African and Latin American and the Caribbean samples, is that in that former we can observe that the privatization of the fixed-line operator and cellular deployment are strongly and positively associated while the later show some weak negative correlation. Hence, we find that privatization and cellular penetration are strongly complementary in Africa while these variables are weak substitutes in Latin America and the Caribbean.

There are also some similarities between the results with Latin American and the Caribbean and African samples. Privatization has not resulted in growth of fixed-line penetration rates in either region. Moreover, in both regions there is a positive relationship between privatization and fixed-line prices, which is particularly strong in Africa. In addition, neither in Latin American and the Caribbean nor in African countries, privatization is significantly correlated with prices in the cellular sector. While private operators often justify increases in prices of fixed-line to raise investment, increases in residential tariffs in our data set did not translate into larger deployment.

In Tables 1 and 2 we can also observe significant differences between Africa countries when analyzed according to their natural endowments and geographical location. 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 while positive in African resource scarce coastal countries. In resource rich countries, privatization is strongly correlated with increases in prices of fixed-line, together with decreases in fixed-line penetration and labor efficiency. In resource scarce landlocked countries, privatization resulted on a significant and negative impact on fixed-line labor efficiency. Finally, in resource scarce coastal countries instead, privatization is correlated significantly and positively both with prices of the fixed-line operator and with labor efficiency.

In terms of the cellular sector, privatization and cellular penetration are strong complements with the African resource rich and resource scarce coastal samples, while these variables are substitutes in the Africa resource scarce landlocked sample. In addition, in neither African sample there is a signifi-

cant impact of privatization on prices of cellular.

To summarize, our analysis suggests there exists a strong relationship between privatization of the fixed-line operator and sector outcomes, particularly for fixed-line prices, fixed-line labor efficiency and cellular deployment. The impact of privatization is non significant on the price of cellular and weak on fixed-line deployment. When comparing across regions, privatization's impact on outcomes is significantly positive in OECD countries (fixed-line labor efficiency) and African resource scarce coastal (fixed-line labor efficiency, cellular deployment), weakly positive in Latin America and the Caribbean countries (fixed-line labor efficiency) and strongly negative in African resource rich countries (fixed-line labor efficiency, fixed-line deployment) and African resource scarce landlocked countries (fixed-line labor efficiency, cellular deployment).

5 Conclusion

This paper has sought to contribute to the debate on the impact of the privatization of the fixed-line operator on telecommunications outcomes. Our work suggests that the divergent results in the empirical literature on the performance of the privatization reform can be explained to a large extent by cross-regional heterogeneity. In particular, our results are remarkably different when considering comparable samples of OECD, Latin America and the Caribbean, African resource rich, African resource scarce coastal, and African resource scarce landlocked countries.

We find that the impact of privatization on outcomes is significant and positive in OECD and African resource scarce coastal countries. In the sample of OECD countries, privatization is positively correlated with fixed-line labor efficiency but has no impact on any other outcome variable. In the sample of African resource scarce coastal countries, privatization is positively correlated with fixed-line labor efficiency, fixed-line prices, and cellular deployment. Rises in fixed-line residential prices to re-balance subsidized tariffs have not translated into larger fixed-line deployment however.

The impact of privatization on outcomes is weakly positive in Latin America and the Caribbean countries. In this sample, privatization is weakly correlated with increases in fixed-line labor efficiency and fixed-line prices. The

impact of privatization is instead strongly negative in African resource rich and African resource scarce landlocked countries. In the sample of African resource rich countries, privatization results on lower fixed-line labor efficiency, higher fixed-line residential prices, and lower fixed-line deployment. The impact of privatization has been the worst in these countries. In the sample of African resource scarce landlocked countries, privatization leads to lower fixed-line labor efficiency and lower cellular deployment.

In our results, we find therefore no significant effects of privatization on fixed-line network expansion in OECD countries consistent with the extent to which there was excess supply at the time of privatization. Privatization reform in non-OECD countries, where fixed-line networks where scarcely developed, has not led however to fixed-line network expansion. Even if one of the reasons put forward by governments to privatize is to increase efficiency, with our data this is only the case for OECD and African resource scarce coastal countries. Residential prices of fixed-line increased with privatization only in African countries which lagged behind their counterparts in re-balancing subsidized tariffs.

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. Privatization entails providing incentives for private actors to commit to long-term investment. The empirical results obtained in this study 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.

Appendix

- **Data**

  The data set constructed for this study contains observations for the period 1985-2007 on the following list of countries:

  - OECD countries (23): Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom and United States.
  - Latin America and the Caribbean (25): 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 and Venezuela.
  - Africa (43): 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, The 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 and Zimbabwe.
  - Middle East (6): Jordan, Lebanon, Oman, Saudi Arabia, Syria and United Arab Emirates.
  - Asia and Pacific (11): Bangladesh, Cambodia, China, India, Indonesia, Malaysia, Pakistan, Philippines, Sri Lanka, Thailand and Vietnam.

  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 and the data sources are given below.

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

Telecommunications reforms

Variable	Source(s)
• Privatization	-Various authors (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	-Various authors (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 regulatory authorities 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	-Idem
• Financial risk	-Idem
• Economic risk	-Idem

Other variables

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

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 activity.
- Price
  - . Monthly subscription to fixed: Recurring fixed charge (in 2000 US dollars) paid by residential subscribers to the PSTN. This charge covers only the rental of the line, not that of the terminal.
  - . 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 pre-paid 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 and 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, in the range between 0-6, is a measure of how responsive government is to its people, on the basis that the less responsive it is, the more likely it is that the government will fall, peacefully in a democratic society, but possibly violently in a non-democratic one.
- Political risk: Composite variable that includes 12 weighted variables covering both political and social attributes. The values of this risk index are in the range 0-100. Higher values of this index reflect low risk.
- Financial risk: Composite variable that includes 5 variables that measure ratios of the national financial structure. The values of this risk index are in the range 0-50. Higher values of this index reflect low 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. Higher values of this index reflect low risk.

Other variables

- Rural population: Variable that indicates the percentage of the total population that resides in rural areas.
- GDP per capita: Gross Domestic Product per capita measured in constant 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.

Table A1
Africa: Classification

Variable	Designation	Countries
dummy_rr	Africa resource rich	Angola, Botswana, Cameroon, Republic of Congo, Zambia Gabon, Guinea, Equatorial Guinea, Liberia, Namibia, Nigeria, Sierra Leone, Swaziland, Algeria and Tunisia.
dummy_rsc	Africa resource scarce coastal	Côte d'Ivoire, Ghana, Kenya, Tanzania, South Africa, Morocco, Benin, Cape Verde, Gambia, Madagascar, Mozambique, Mauritius, Senegal, Seychelles, Togo and Egypt.
dummy_rsl	Africa resource scarce landlocked	Malawi, Uganda, Burundi, Burkina Faso, Central African Republic, Ethiopia, Lesotho, Mali, Malawi, Niger, Chad, Democratic Republic of Congo and Zimbabwe.

- **Descriptive statistics**

Table A2
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 A3
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 A4
Summary statistics: Latin America and the Caribbean

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 A5
Summary statistics: Africa

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 A6
Summary statistics: Africa resource rich

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 A7
Summary statistics: Africa resource scarce coastal

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 A8
Summary statistics: Africa resource scarce landlocked

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

Table A9
Correlation coefficients

Privatization	*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 the Caribbean	0.08	0.19	0.18	0.22	-0.03
Africa	0.26	0.35	0.30	0.05	-0.12
Africa resource rich	0.48	0.35	0.45	0.42	-0.17
Africa resource scarce coastal	0.12	0.30	0.11	0.10	-0.04
Africa resource scarce landlocked	0.08	0.33	0.22	0.07	-0.13

- **Regressions**

Table A10
Fixed-effect: OECD countries

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

*/**/*** stands for significance at the 10%/5%/1%.

Table A11
Random-effect: OECD countries

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

*/**/*** stands for significance at the 10%/5%/1%.

Table A12
Fixed-effect: non-OECD countries

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

*/**/*** stands for significance at the 10%/5%/1%.

Table A13
Random-effect: non-OECD countries

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

*/**/*** stands for significance at the 10%/5%/1%.

Table A14
Fixed-effect:
Latin American and The Caribbean

y_{it}	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$
$priva_{it}$	0.043	-0.016	0.001
$comp\_cel_{it}$	0.136***	0.073	0.201***
reg_{it}	0.073**	0.125**	0.223***
$demo_{it}$	0.009	-0.0318	-0.035
p_risk_{it}	0.003	-0.006*	0.009
f_risk_{it}	0.004**	-0.009**	-0.000**
e_risk_{it}	-0.000	-0.001	0.009*
$rural_{it}$	0.032***	-0.015*	0.087***
gdp_{it}	-0.611**	0.000***	0.000
$const$	0.852***	-0.812**	1.024**
Time	Yes	Yes	Yes
F	108.34***	365.80***	48.94***
Obs.	498	497	423
y_{it}	$log(p\_res_{it})$	$log(p\_cel_{it})$	
$priva_{it}$	0.297	-0.327	
$comp\_cel_{it}$	-0.286*	0.047	
reg_{it}	-0.081	0.170	
$demo_{it}$	-0.201***	-0.106	
p_risk_{it}	0.001	0.008	
f_risk_{it}	-0.033***	-0.012	
e_risk_{it}	-0.004	-0.001	
$rural_{it}$	0.023	-0.134***	
gdp_{it}	0.000***	0.000***	
$const$	1.705	1.667	
Time	No	Yes	
F	8.35***	12.73***	
Obs.	318	217	

*/**/*** stands for significance at the 10%/5%/1%.

Table A15
Random-effect:
Latin American and The Caribbean

y_{it}	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$
$priva_{it}$	0.014	-0.094*	0.130**
$comp\_cel_{it}$	0.075**	0.086	0.328***
reg_{it}	0.083**	0.114*	0.124
$demo_{it}$	0.017	-0.039	0.089**
p_risk_{it}	0.004**	0.003	0.021***
f_risk_{it}	0.002	-0.015***	-0.016**
e_risk_{it}	0.005*	0.007*	0.022***
$rural_{it}$	-0.004	-0.006**	-0.020***
gdp_{it}	0.000***	0.000***	-0.000***
$const$	0.672	0.262	3.150***
Time	Yes	Yes	Yes
$Wald$	2590.59	10264.91***	753.72***
Obs.	498	497	423
y_{it}	$log(p\_res_{it})$	$log(p\_cel_{it})$	
$priva_{it}$	0.336**	-0.144	
$comp\_cel_{it}$	-0.421***	-0.231	
reg_{it}	-0.019	-0.082	
$demo_{it}$	-0.165**	-0.191***	
p_risk_{it}	0.006	0.043***	
f_risk_{it}	-0.042***	-0.017	
e_risk_{it}	0.000	-0.001	
$rural_{it}$	-0.001	-0.009*	
gdp_{it}	0.000	0.000	
$const$	3.411***	-1.181	
Time		Yes	
$Wald$	72.79***	243.42***	
Obs.	318	217	

*/**/*** stands for significance at the 10%/5%/1%.

Table A16
Fixed-effect: Africa

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

*/**/*** stands for significance at the 10%/5%/1%.

Table A17
Random-effect: Africa

y_{it}	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$
$priva_{it}$	-0.119***	0.236***	-0.113**
$comp\_cel_{it}$	-0.022	0.135**	0.083*
reg_{it}	0.113**	0.156***	0.0340
$demo_{it}$	0.020	-0.089***	-0.014
p_risk_{it}	-0.003	0.004*	-0.005**
f_risk_{it}	0.004	0.006	0.010***
e_risk_{it}	0.001	-0.004	-0.001
$rural_{it}$	-0.014***	-0.005***	0.000
gdp_{it}	0.000***	0.000***	0.000***
$const$	-0.265	0.254	2.501***
Time	Yes	Yes	Yes
$Wald$	1083.36***	5182.54***	1232.24***
Obs.	764	774	626
y_{it}	$log(p\_res_{it})$	$log(p\_cel_{it})$	
$priva_{it}$	0.430***	0.096	
$comp\_cel_{it}$	0.070	-0.273**	
reg_{it}	0.131	-0.505***	
$demo_{it}$	-0.080**	0.016	
p_risk_{it}	0.004	-0.003	
f_risk_{it}	-0.018**	-0.025	
e_risk_{it}	0.014**	0.006	
$rural_{it}$	0.028***	0.014*	
gdp_{it}	0.000**	0.000	
$const$	0.747	-0.299	
Time	Yes	No	
$Wald$	532.27***	72.00***	
Obs.	529	312	

*/**/*** stands for significance at the 10%/5%/1%.

Table A18
Fixed-effect: Africa per region

y_{it}	$log(ml_{it})$	$log(cel_{it})$	$log(eff_{it})$
$priva_{it} * dummy\_rr$	-0.305***	0.321***	-0.279***
$priva_{it} * dummy\_rsc$	0.027	0.364***	0.219***
$priva_{it} * dummy\_rsl$	-0.066	-0.342***	-0.686**
$comp\_cel_{it}$	-0.037	0.135**	0.051
reg_{it}	0.087**	0.188***	0.063
$demo_{it}$	0.015	-0.085***	0.000
p_risk_{it}	-0.004**	0.001	-0.008***
f_risk_{it}	0.006**	0.002	0.012***
e_risk_{it}	-0.000	-0.002	-0.002
$rural_{it}$	-0.014***	-0.020***	0.008
gdp_{it}	0.000***	0.000***	0.000***
$const$	0.062	1.177**	1.913***
Time	Yes	Yes	Yes
F	32.59***	171.69***	43.66***
Obs.	764	774	626
y_{it}	$log(p\_res_{it})$	$log(p\_cel_{it})$	
$priva_{it} * dummy\_rr$	0.261*	0.339	
$priva_{it} * dummy\_rsc$	0.790***	0.207	
$priva_{it} * dummy\_rsl$	0.094	0.007	
$comp\_cel_{it}$	0.104	-0.115	
reg_{it}	0.100	-0.416***	
$demo_{it}$	-0.067**	0.016	
p_risk_{it}	0.002	-0.007	
f_risk_{it}	-0.014*	-0.015	
e_risk_{it}	0.013**	0.002	
$rural_{it}$	0.037**	0.109***	
gdp_{it}	0.000***	0.000	
$const$	0.144	-6.595**	
Time	Yes	No	
F	17.98***	8.06***	
Obs.	529	312	

*/**/*** stands for significance at the 10%/5%/1%.

Table A19
Random-effect: Africa per region

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

*/**/*** stands for significance at the 10%/5%/1%.

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