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Quality of institutions and productivity of State-Invested Enterprises: International evidence from major telecom companies

Paolo Castelnovo, Chiara F. Del Bo, Massimo Florio *

Università degli Studi di Milano, Dipartimento di Economia, Management, Metodi Quantitativi, Via Conservatorio 7, Milano, 20122, Italy

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ABSTRACT

The quality of institutions is at the core of the differences in the growth of income and productivity of nations. A growing body of evidence shows how this is also true at the firm level. After taking stock of earlier theoretical and empirical literature on the efficiency of state-owned versus private enterprises, while we consider ownership as the core internal governance mechanism of firms, we add quality of government as a determinant of the external institutional environment. To disentangle the effect of internal and external institutions on firms' productivity, we use different sets of ownership and institutional environment indicators.

After having identified the top 350 private, state-invested (i.e. partially state-owned) and state-owned enterprises in the telecommunications industry in EU28 and in more than 60 other countries between 2007 and 2015, we empirically investigate models of firms' productivity augmented with ownership and quality of government. Our findings suggest that, after controlling for the regulatory and competitive conditions at the country level, on average, public ownership has a negative impact on firm-level TFP. This effect is however mitigated by high external institutional quality and even reversed in some countries with a particularly favourable institutional environment.

1. Introduction

According to earlier theoretical and empirical literature, state-owned enterprises (henceforth, SOEs) are expected to be less efficient than their private counterparts (see e.g. the popular survey by Megginson and Netter, 2001 or more recently Megginson, 2016).

Despite mass privatization reforms implemented in the past decades, governments still own and manage substantial productive assets in many economic sectors. According to Christiansen and Kim (2014), 282 out of the world's 2000 largest companies ('Forbes Global 2000' top corporation list) are SOEs (including state-invested enterprises where the government is a shareholder with other investors). Recent data (OECD, 2017) show that, at the end of 2015, SOEs are valued together at over 2.4 trillion USD and employ, cumulatively, more than 9.2 million workers.

As the appointment and incentives of managers in SOEs is influenced by governments, bad decisions will be taken by bad governments. But is the reverse true? In countries where the overall institutional quality is high, are SOEs relatively more efficient?

Several channels through which institutional aspects can influence firm-level activities can be envisaged. For example, if there is pervasive corruption of government officials in one country, doing business there means that a firm has to face direct extra-costs relative to a firm in another country where civil servants and politicians are more honest (see e.g. Brooks et al., 2013).

* Corresponding author.
E-mail address: massimo.florio@unimi.it (M. Florio).

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The lack of stability of legislation or of its interpretation by courts may hinder corporate investment, and this also generates inefficiency. Democracy itself is often regarded as a form of political competition leading on average to choosing more honest and better qualified politicians than otherwise, and better politicians may pass better legislation, with beneficial effects for competition (see Besley, 2006).

While these aspects have been explicitly and extensively considered in previous literature on economic growth and determinants of firms' productivity, very few previous studies have considered the differential impact that the institutional environment may have on the productivity of public versus private firms.

While good institutions are beneficial for all firms, they should exert particularly positive effects on public enterprises, since they might mitigate the structural causes of the inefficiency gap with private firms. More specifically, while for private enterprises good institutions are beneficial in shaping the environment in which they compete, for public enterprise there is an additional effect on the internal governance of the firm. Thus public enterprises benefit from a high institutional quality both in terms of operating in a favourable external environment, as all firms, but also in terms of reaping the benefits that institutional quality has on the internal governance of the firms. For example, one of the possible causes of inefficiency of government owned firms is related to the fact that owners of firms appoint managers and, in corrupt environments, the decision process may be driven by distorted motivations that deviate from efficiency. In a favourable institutional environment, instead, good government may be less inclined to cronyism in selecting executive directors of SOEs and this may reduce the gap in efficiency with private enterprises. Hence, we want to empirically test the differential impact of external institutions on firms' productivity according to their private versus public ownership.

The privatization of British Telecom was often identified as the most important historically (see Megginson and Netter, 2001), since it allowed privatization to become an established economic policy tool. Looking back to the 1980's, the telecommunications industry was the most important sector affected by privatization and liberalisation reforms in Europe (Florio, 2003, 2013), along with other network industries (Clifton et al., 2006). For an overview of the underlying motivations and outcomes of the reform process in the telecommunications sector in Europe, see Belloc et al. (2013).

For several reasons the telecommunications industry is an ideal testing ground for our question: it is the industry where privatization policy started in the UK more than 30 years ago (Clifton et al., 2006); the services provided are essential for the overall performance of the economy; the available technology is relatively homogeneous across countries (differently, for example, from the energy industry), thus efficiency comparisons at the firm level are straightforward. However, the privatization process was not homogeneous neither in its timing nor its pace: a mixed-oligopoly, where private and SOEs or state-invested enterprises[1] (henceforth, SIEs) coexist, has mainly emerged in Europe in the last three decades (e.g. in Belgium, Denmark, France, Germany, Norway and Sweden). Nowadays, the State is still a major player in the telecommunications industry not only in Europe but also worldwide, notably in China and in other Asian countries.

However, if the difference in performance between private and public firms is due to distorted incentives for the latter, then good institutions, by shaping the environment in which firms operate, may help closing the gap, reducing the likelihood of rent-seeking and opportunistic behaviour of managers and politicians. Moreover, if the quality of institutions is correlated with firms' outcomes, then earlier empirical studies of the relative difference in performance between private and public enterprises may have omitted potentially relevant explanatory variables.

Our research questions are thus the following: is the quality of external institutions related to firm-level productivity? Is there a differential impact of institutions according to firms' ownership type? Does the quality of external institutions modify the impact of ownership on productivity?

To answer these questions we built a worldwide database from around 350 top telecommunication companies between 2007 and 2015. Firm-level information is obtained from the Orbis Database, country-level institutional features are extracted from the Quality of Government Social Policy Dataset and additional information on GDP is taken from the World Bank Development Indicators.

We find that a negative and statistically significant relationship exists between public ownership and telecommunications companies' total factor productivity (henceforth, TFP), as per earlier literature. Such effect is, however, counterbalanced by institutional quality. The lower the quality of country institutions the higher is the gap between SOEs, SIEs and private enterprises, but in countries with high institutional quality, this effect is reversed. This result helps advance our understanding of productivity determinants and their interplay, focusing on the role of both external and internal institutions. A novelty of our approach is the use of a continuous variable for public ownership, allowing to capture the impact of different levels of state investment on TFP.

The paper is organised as follows: Section 2 reviews earlier literature on the role of ownership and institutions on firm productivity; Section 3 presents some key features of the industry, describes data sources and shows descriptive statistics; Section 4 describes the empirical strategy implemented, discusses the regression results and performs robustness checks. Finally, Section 5 contains concluding remarks and policy implications.

2. Ownership, institutions and firms' performance: evidence from earlier literature

Our contribution is related to two broad strands of literature. The first considers the impact of ownership on firms' productivity and performance. The second examines the role of institutional quality as a determinant of productivity.

The impact of ownership on firms' performance was broadly investigated by several theoretical and empirical contributions. The

[1] While firms are usually labelled as SOEs when the majority of their equity is owned by a government, the broader category of State-Invested Enterprises includes companies where the government has at least 10% ownership (see Christiansen and Kim, 2014).

traditional view of public ownership, as presented in public economics textbooks, such as in Lecture 16 of Atkinson and Stiglitz (2015), was to assume that SOEs could counteract market failures, such as natural monopoly, public goods, externalities and incomplete markets. The main criticism to this argument was that government failures may be even greater than market failures. In a property right theory perspective, going back to Coase (1937), private ownership clearly defines claims to profits and hence provides the right incentives to managers. In the words of Alchian and Demsetz (1973, pg. 18) "The most important distinction is between state (public) and private ownership", because in the former case the state is an abstraction where politicians or bureaucrats have no incentive to guarantee the citizen-owner rights. Thus ownership should be seen as an institutional arrangement that allocate the right to use a good, to appropriate its fruits, to alter it including the right to transfer ownership to a third party. Barzel (1997, 2002) offers an original reconsideration of the property rights perspective, beyond the legal dimension.

In the public-choice approach, going back to the contributions of Downs, Niskanen, Buchanan, and Tullock, extensively reviewed by Mueller (2003), the public owner is in fact a set of interests and objectives, often conflicting, and embodied in different layers of decision-making. According to Niskanen (1971), individual utility in the public sector is ultimately made of the three 'p-objectives: pay, power, and prestige. Hence SOEs' managers and their political principals have no incentive to maximize the efficiency of the firm.

A third perspective leading to an expectation that SOEs must be inefficient is the 'Austrian' view (see Hayek, 1945, for a seminal contribution and, e.g. Huang et al., 2017, for a more recent take on this perspective) that points to the fact that SOEs are sheltered from competition, which –differently from the neo-classical tenets- is related to the best possible use of incomplete information as provided by disequilibrium prices. Thus SOEs, as they often enjoy protection in the form of legal monopoly or other barriers to entry, would tend to be less innovative than private firms, because innovation arises as a response to competition under incomplete information.

Finally, principal-agent theory has reconsidered the previous hypotheses, pointing to information asymmetries between owners and managers (Laffont and Tirole, 1993, 2000) in both public and private organizations, with ambiguous predictions on the relative efficiency. Obinger et al. (2016) review some more recent literature on the political economy of privatization, which is to a certain extent related to the conflicting views on SOEs, although they do not explicit focus on productivity issues.

As it often happens in economics, empirical analysis should help to confirm or reject theoretical models, but the evidence is still inconclusive. A large empirical literature has investigated the impact of ownership on firms' economic outcomes such as profitability and productivity. Studies finding a negative effect of State ownership often attribute the difference in economic results to the potentially distorted objective function of public firms, which might pursue either politicians' individual goals (Shleifer and Vishny, 1993, 1994) or social aims, such as correcting market failures and taking social welfare into account (Atkinson and Stiglitz, 2015) and targeting employment objectives (Shleifer, 1998).

Earlier literature frequently found that government ownership, compared to private ownership, is associated with lower productivity in such industries (see e.g. Boardman and Vining, 1989). However, other contributions highlighted that public versus private ownership is not necessarily associated with worse economic outcomes. For example, Millward (1988), Parker and Liang Wu (1998) and Willner (2001) found that either ownership has no statistically significant impact on performance or public ownership is actually associated with a premium with respect to private ownership. A recent review of the empirical evidence on private and public enterprises' efficiency suggests that 'research does not support the conclusion that privately owned firms are more efficient than otherwise-comparable state-owned firms' (Muhlenkamp, 2015 p. 553). Belloc (2014) suggests that, contrary to the conventional wisdom, SOEs' inefficiency is not due to state ownership per se but is likely related to other conditions, such as institutions, culture, legislation and the degree of political competition.

Whatever the evidence, as a matter of fact SOEs still exist, in spite of three decades if privatization, and have often taken the form of state invested enterprises (SIEs), where government may be minority shareholders (e.g. owning less than 51% of equity but often the top ones).

The role for State intervention in the economy has increased during and after the recent Great Recession, spurring a renewed interest in the analysis of performance of public and private enterprises. The presence of public bodies as either owners or shareholders is particularly relevant when the provision of services of general interest and network utilities is concerned (OECD, 2017).

Christiansen and Kim (2014) provide evidence of the increasing role of public enterprises in the marketplace over the last decade and compare the performance of SIEs and non-SIEs in five sectors (air transportation, electricity, mining, oil & gas and telecommunication) showing that, over the last ten years, SIEs have generally enjoyed higher rates of return than comparable private companies. The Great Recession sharpened this trend, with governments rescuing major private enterprises in distress, particularly banks. Recent research on mergers and acquisitions (M&A) confirms that in the last decade there has been an increase of publicisation deals relative to privatisations (see Hall et al., 2013). From the analysis of M&A deals, Clò et al. (2017) and Del Bo et al. (2017) found that public firms are currently extremely active in the global market arena.

However, even when private firms are more efficient than SIEs, other factors besides ownership can explain the difference in performance. Among them, the external institutions, i.e. the economic and political institutions of a country, play a crucial role: they act as "constraints" and set the "rules of the game" that regulate the interactions among economic organizations, which, in the words of North (1990), are the "players of the game". For an in-depth discussion about the relationship between institutions and organizations and the distinction between external (national-level) and internal (firm-level) institutions see Pelikan (2003).

The hypothesis that differences in economic and political institutions lead to different economic outcomes has its core in the idea that "*it is the way that people decide to organize their societies that determines whether or not they prosper*" (Acemoglu et al., 2005, p.397). Some ways of organizing societies encourage the economic actors to undertake crucial actions, like innovating, taking risks, saving, solving collective problems and providing public goods, while others do not.

External institutions thus shape the economic environment where individuals and firms operate; for this reason, a growing body of literature has been exploring the link between institutional quality and economic performance. This is the second strand of literature the

present paper refers to.

The role of external institutions in determining economic outcomes was investigated from different perspectives, mostly at the macro-level with more recent literature also exploring the micro evidence.

One of the first and most influential study in this field is Hall and Jones (1999), suggesting that countries with a better institutional environment are characterised by higher levels of labour productivity and showing that such relationship is causal. Tabellini (2005) argues that the real difference between success and failure in economic development is made by the basic institutional and legal infrastructures that protect property rights, enforce the rule of law and prevent abuse by governments. Similarly, Acemoglu and Robinson (2008) attribute the main differences in prosperity across countries to differences in economic institutions, which in turn depend on the nature of political institutions and the distribution of political power in society: solving the problem of development will ultimately entail reforming these institutions. Efendic et al. (2011) analyze the literature examining the nexus between institutions and economic performance at the macro-level concluding that empirical studies support the existence of a positive and significant effect of institutional quality on output levels and growth.

The impact of external institutions on firm-level performance has been recently examined by Commander and Svejnar (2011), Driffield et al. (2013) and De Rosa et al. (2015). While the evidence provided in Commander and Svejnar (2011) suggests that country fixed-effects, other than institutional quality, capture most of the time invariant factors influencing firm-level performance, De Rosa et al. (2015) find that corruption, especially in countries with a weak legal framework, has a detrimental effect on firm-level performance. Driffield et al. (2013) introduce ownership as a factor influencing the impact of external institutional quality on firms' performance and find that institutional reforms leading to increased country-level competition influences mainly State-owned firms. Nguyen and Jaramillo (2014) compare the return to innovation across countries with different levels of institutional quality. They find that in countries with lower institutional quality (specifically, rule of law, regulatory quality, property and patent right protection) the return to firms' innovation is lower, discouraging investments in research and the adoption of new products. Focusing specifically on the telecommunications industry, Börsch (2004) examines the firm-level changes after sector liberalisation, highlighting that firms' responses to a similar set of reforms depends on the institutional environment of the countries where they are located.

It is worth noticing that lobbying activities of (big) firms may influence the quality of economic institutions and thus their impact on economic outcomes. According to Olson (1982) companies may lobby for new economic institutions favouring their business interests, like regulatory barriers that decrease competition. Self-interested lobby groups can even disrupt development in otherwise stable political environments (Olson, 1982) and their interaction with public officials may sustain socially sub-optimal institutions (Grossman and Helpman, 1994).

Heckelman and Wilson (2013) show that the impact of institutions on economic growth depends not just on their current state but on their evolution. Focusing on institutions that foster economic freedom, they demonstrate that if economic freedom emerges spontaneously it may be growth promoting, while if it is the result of costly lobbying efforts it might be less growth enhancing. Moreover, the impact of institutions on growth diminishes as lobbying efforts increase.

Unfortunately, our data do not allow to account for the potential impact of firms' lobbying activity; in the light of the relevant size of the companies in our sample and, therefore, their likelihood to be intermingled with the public sector, this could be an interesting topic for future research.

Related to the overall institutional setting other external conditions that may have an impact on firm-level performance are the regulatory environment and, consequently, the level of competition in the industry. With respect to the former, advances in technology since the 1980s have significantly modified the approach of regulatory authorities, which in turn are less frequently government departments than in the past and have taken the form of independents national regulators. Moving from a situation of natural monopoly, where competition was deemed counterproductive, to a more complex technical landscape, regulation has evolved from dealing with a single public incumbent to a market with potentially many competitors. Initially, the newly established independent regulatory authorities adopted command and control mechanisms, while the technological evolution since the 1990s induced a shift towards incentive-based regulation. Further technical progress is once again changing the landscape, with a resurgence of arguments suggesting the natural monopoly feature of segments of network industries (Florio, 2013). The impact of the regulatory regime and market structure on firm-level performance and productivity in the telecommunication industry suggests that the results are not straightforward and depend on the timing and combination of reforms. Li and Xu (2004) examine worldwide panel data between 1990 and 2001 for several performance indicators in the telecommunication industry and find evidence of complementarity between privatization and competition-promoting reforms, while also hinting to a time lag in the manifestation of reform effects. Regarding the timing of reforms, Zhang et al. (2005), for example, provide evidence suggesting that introducing reforms that support and enhance competition before initiating the privatization process in the electricity generation industry, has positive implications in performance measures. Also, empirical results hint towards a differential impact of regulation and competition on public incumbents acting as monopolists or on privatised firms. For example, Wallsten (2001), based on an analysis of African and Latin American countries between 1984 and 1997, finds that an independent regulatory authority combined with privatization yields increases in efficiency, while privatization per se does not bring about significant benefits. Wallsten (2002) finds that the establishment of an independent regulatory authority prior to privatization of the industry yields increases in efficiency. Ros (1999), using data from several countries between 1986 and 1995, reports that competition has a positive effect on efficiency measured as main lines per employee. Along the same lines, Boylaud and Nicoletti (2000) find that for OECD countries between 1991 and 1997, measures encouraging competition enhance productivity. Laffont (2005) in his posthumous book 'Regulation and Development' also points to the limited role of privatization in enhancing productivity when regulators are captured by vested interests.

Borghi et al. (2016) provide a synthesis of the strands of literature described above focusing both on ownership, as the core internal institution of firms, and on the quality of government, as the most important external institutional feature. Working with a sample of

firms operating in the European electricity distribution sector, they find that public ownership is associated with lower productivity levels when the quality of government is poor and with higher productivity in countries characterised by higher institutional quality.

We extend this analysis in three ways: first, we focus on the telecommunications sector, a key industry in the perspective of privatization policies; second, we build a worldwide dataset of the top companies; third, we explore the role of public investment moving beyond a dicothomic distinction between private and public ownership.

An example can help to better understand the relevance of our approach to empirically representing public ownership. Using an indicator variable, Telecom Egypt and T-Mobile are both classified as publicly-owned due to the nature of their GUO: the Government of the Arab Republic of Egypt and Deutsche Telekom, respectively. However, while in the first case the GUO is a government owning 80% of the company's shares, the investment of the German government in T-Mobile is less direct and significantly lower (31.7%). Using the continuous public ownership variable in the empirical analysis allows us to account for these differences, better understanding the role of public ownership and investment as a determinant of firm-level productivity.

We discuss later how ownership interacts with the institutional setting in our framework.

3. Key features of major telecoms worldwide and the data

As mentioned earlier, the first country implementing privatization reforms in Europe was the U.K., with the sale of 51% of British Telecom's shares in 1984, followed by Italy (1991), Denmark (1992), the Netherlands (1994), Belgium, Greece and Portugal (1995), Germany (1996), France (1997), Switzerland (1998), Austria, Norway and Sweden (1999) (see Alonso et al., 2013).

However, the speed and rate of privatisations were very different across Europe, with countries like Spain and Denmark completing the privatization process in few years; countries like the U.K, Italy and Netherlands that took about a decade to achieve a fully-privatised sector; and others, like Germany, France, Sweden, Finland, Belgium, Austria, Norway and Switzerland, where governments still have important stakes in the former incumbents. What has emerged from the implementation of the liberalisation and privatization telecom reforms in Europe is a mixed-oligopoly where private, SOEs and SIEs coexist. Nowadays, the most important remaining SOEs are Swisscom and Belgacom (with more than 50% of shares in public hands), while the most important SIEs are Deutsche Telekom, Orange, Teliasonera, O.T.E. and Telekom Austria (around 30%). In Russia, despite the privatization reforms that interested large sectors of the economy in the last decades, telecommunications companies like Transtelecom and OJSC Svyaztransneft are still 100% under State-control.

On the contrary, in North America (U.S.A. and Canada) and Oceania (Australia and New Zealand) the telecommunications sector is entirely under private ownership. However, while in Canada and the U.S. private ownership emerged since the early stages of the industry, the privatization process was completed in 1991 in New Zealand and only in 2011 in Australia, when the Australian Government sold its remaining shares in the former incumbent Telstra.

In Asia public ownership is still widespread in many countries. In China the telecom industry is mostly in the State's hands. The Japanese Government still holds more than 30% of the shares of the previous public monopolist NTT, partly privatised in 1985. In India two of the largest telecom enterprises are controlled either directly or indirectly by a public entity: Tata Communication Limited, with 26% of shares owned by the Indian Government, and Bharti Airtel, of which the Singapore Government holds 22% of shares via Singtel.

SIEs are largely present in Vietnam (e.g. Vietnam Telecom Service Company, Vietnam Mobile Service Company and VTC Online), Indonesia (e.g. PT Indosat, XL Axiata and Tiphone Mobile Indonesia) and, even if in smaller extent, in South-Korea (KT Corporation) and Philippines (Globe Telecom).

Relevant SOEs and SIEs can also be found in the telecommunications sector of Middle-Eastern countries, like the United Arab Emirates (Emirates Telecommunication Group Company, 60% of State-ownership), Oman (Oman Telecom Company, 70%), Baharain (Baharain Telecommunications Company, 56%), Qatar (Ooreedo, 78%), Saudi Arabia (Etihad Etisalat, 27%) and Iran (Iran Telecommunication Public Shareholding Company, >50%), with the only exception of Israel where, during the 1990s, after the privatization of the public incumbent Bezeq, the telecommunications industry transitioned from a government-owned monopoly to a fully private market with a range of new companies.

Particularly interesting is the case of Centre- and South-America where, while private ownership is prevalent in some countries (see Argentina, Brazil, Mexico and Chile), the telecommunications sector previously privatised during the 1990s has recently come again into State ownership in Venezuela and Bolivia. This is the case of the Venezuelan company CANTV, nationalised in 2007 by President Hugo Chavez, and of the Bolivian firm ENTEL, nationalised in 2008 by President Evo Morales.

In Africa SOEs and SIEs are present, for example, in Egypt (Telecom Egypt, 80% of public shares), Morocco (Maroc Telecom, 30%), South Africa (Telkom S.A., 39%) Sudan (Sudatel, >60%) and Kenya (Safaricom, 35%).

3.1. Data

Firm-level data for our empirical analysis are extracted from the *Orbis* database, which contains financial and ownership information on worldwide public and private enterprises. Exploiting this dataset, we built a sample of 700 telecommunications companies by selecting the top enterprises by operating revenues from 7 macro-areas (Europe, Africa, Asia, Middle-East, Oceania and North-, Central- and South-America). Specifically, the selection criteria is the following: in each country the largest company in terms of operating revenues in 2015 is identified and then all the firms reporting operating revenues above 3%[2] of those of the incumbent are included in

[2] Visual inspection of the data suggest that below this threshold most companies are either ancillary service companies or marginal players active only in very specific segments of the industry.

the sample.

After dropping companies with missing financial data for the purpose of our analysis (for example missing data on assets or employment) and ownership information (no information on the equity structure or missing identification of the GUO) we are left with a sample of 348 firms from 90 different countries. The time-span ranges from 2007 to 2015, for a total of about 1800 observations.

Balance-sheet data (specifically operating revenues, tangible fixed assets, material costs and number of employees) are used to compute firms' total factor productivity (TFP), which is the dependent variable of interest in our econometric analysis.

Ownership data include information on both the GUO and the amount of equity held by different shareholders, providing a description of their 'type' (e.g. Financial company; Mutual & Pension Fund; Industrial company; One or more named individuals or families; Public authority, State, Government; etc.). As a further check, ownership data were verified through enterprises' websites or by considering additional publicly available information.

We consider public ownership by means of a continuous variable providing information on the percentage of shares held by public shareholders, ranging from 0 (fully privatised companies) to 100 (fully State-Owned enterprises). We thus consider both SOEs and SIEs. As a robustness check, we also use a dichotomic variable which classifies companies as State-invested if the government either holds at least 10% of their shares (see Christiansen and Kim, 2014) or it is flagged as the GUO.[3]

This represents a novelty with respect to most of the previous studies comparing the performance of private and public companies, that typically rely on dichotomic ownership variables taking value 1 if either the top shareholder or the GUO are States or Public Authorities and 0 otherwise (e.g. Borghi et al., 2016).

Table A1 in Appendix A summarises companies' distribution by country and ownership type. European enterprises represent by far the largest portion of our sample (almost 54%) followed by Asian (20%), Centre- and South-America (10%) and Middle-east (7%) companies, while African and North-American[4] firms are a small fraction of the total.

Moving on to the analysis of firms' financial characteristics, Table 1 below shows the average values of companies' main budget data in 2014, the most recent year with the largest number of observations available. Statistics are provided also distinguishing by ownership type.

SIEs are on average larger than private companies in terms of operating revenues, total assets and number of employees. However, the difference in mean is statistically significant at the 1% level only for the number of employees, while it is not significant for revenues nor for total assets.

Country-level data about the quality of the external institutional environment are taken from the *Quality of Government* (QoG) *Social Policy Dataset* (Teorell et al., 2016), maintained by the QoG Institute,[5] which collects indicators of governance and institutional quality taken from different sources.

Following recent literature on the determinants of micro and macro productivity (e.g. Lasagni et al., 2015; Tebaldi, 2016), we focus on an aggregate indicator which aims to capture the several and multifaceted aspects of institutional quality in a synthetic measure. To this end we consider the *Quality of Government (QoG)* composite indicator, developed by the International Country Risk Guide, computed as the mean of three underlying variables on 'Corruption', 'Law and Order' and 'Bureaucracy Quality'. The indicator is a continuous variable between 0 and 1 with higher values corresponding to higher quality of government.[6]

Given the large number of countries included in our sample, Table 2 provides the average values of the QoG index only for the seven macro-areas considered, even if we are aware of the heterogeneity that could exist in the institutional quality of countries belonging to the same macro-area.

As expected, Oceania, North-America and Europe display the highest value for the QoG indicator. Middle-East, Asia and Centre-South America follow, while Africa exhibits the lowest value.

It is worth stressing, especially for the correct interpretation of the regression coefficients presented in the next section, that high scores are associated with a good quality of governance and institutions, while low values are synonymous of poor quality.

Information on the regulatory and competitive environment is taken from the ICT Regulatory Tracker by the International Telecommunication Union (ITU) and gathers information on 190 countries over the 2007–2016 period. Based on both quantitative and qualitative information, a set of 50 indicators are computed and grouped into four "clusters": i) Regulatory Authority; ii) Regulatory Mandate; iii) Regulatory Regime and iv) Competition Framework. For the purpose of our analyses, we focus on the first and fourth cluster, following previous literature (briefly commented upon in Section 2) which suggest the importance, for firm-level efficiency variables, of the establishment of independent regulatory authority and the degree of competition in the industry.

The first cluster (Regulatory Authority) includes 10 sub-indicators and is concerned with regulatory independence, outlining the main features of the National Regulatory Authorities. The fourth cluster instead is made up of 14 sub-indicators tracking the level of competition in the ICT industry.

Each sub-indicator is assigned a score of 0, 1 or 2[7] and are then aggregated, with equal weights, within each cluster. The resulting cluster-specific indices are those used in the subsequent empirical analysis.

[3] In the empirical section we thus use a slightly more nuanced definition of state-investment with respect to the one used in the introductory Section for descriptive purposes only.

[4] All Canadian companies were dropped from our original sample because of missing financial information.

[5] QoG institute is an independent research institute within the Department of Political Science at the University of Gothenburg.

[6] In order to confirm the robustness of our results to alternative indicators that measure other aspects of the multi-faceted concept of institutional quality, in Section 4.3 we present results using other measures and proxies for this variable.

[7] With 2 corresponding to the best scenario based on international regulatory best practices.

Table 1
Summary statistics.

	Full Sample	Private	State-invested
Operating Revenues (thd $)	6,547,472	6,258,055	6,958,494
Total Assets (thd $)	13,886,087	13,342,395	14,651,763
Employees	20,426	14,098	29,671

Source: Orbis, authors' elaboration

Table 2
Average values of the QoG indicator by macro-area 2007–2015.

	Quality of government
Africa	0.385
Asia	0.533
Europe	0.755
Middle East	0.621
North America	0.830
Oceania	0.908
South-Central America	0.507

Source: QoG dataset, authors' elaboration

4. Empirical analysis

4.1. Model specification

In order to investigate empirically the influence of internal and external institutions and their interaction on firms' productivity, we follow the theoretical framework developed by Borghi et al. (2016), and derive an empirical model where total factor productivity (henceforth, TFP), our dependent variable, is obtained as a residual from the firm's production function.

As in the econometric literature surveyed by Van Beveren (2012), we adopt a two-step procedure. In the first-step companies' TFP, viewed as an indicator of firm performance, is computed with three estimation techniques, while in the second the estimation of TFP determinants is performed. In the first step, TFP estimated as a residual from a production function reflects output differences that are not explained by differences in the inputs used in the production process (see for example Lichtenberg and Siegel, 1990; Javorcik, 2004 and Syverson, 2011).

We start from a simple firm-level Cobb-Douglas production function where the output, measured by operating revenues (*OR*), is produced using labour (*empl*), capital in the form of tangible fixed assets (*TFA*) and material costs (*MC*), obtained as the difference between sales and value added:

$$\ln(OR_{it}) = \beta_0 + \beta_1 \ln(empl_{it}) + \beta_2 \ln(TFA_{it}) + \beta_3 \ln(MC_{it}) + v_i + u_{it} \quad (1)$$

where subscripts *i* and *t* refer to firms and time, respectively, and the time- and firm- specific error term is broken down in a firm-specific observable component (*v*) and an *iid* component (*u*).

First, we estimate equation (1) using Fixed-Effects. Then, TFP is computed as the residual of the estimated production function, that is as the difference between the actual and predicted level of output (*TFP CD*). If, however, unobserved productivity shocks are correlated with the choice of inputs by firms, this methodology may produce biased coefficients.

In order to overcome this problem, we estimate TFP with the Levinsohn and Petrin (2003) methodology where intermediate inputs are used as proxies of the unobserved productivity shocks at the enterprise level (*TFP LP*). Finally, TFP is measured by means of stochastic frontier analysis (henceforth, SFA). This methodology (Aigner et al., 1977; Kumbhakar and Lovell, 2000) provides estimates of the inefficiency of firms, represented by the difference between the optimal frontier objective, itself made up of a deterministic and stochastic part, and the firm's observed outcome (in our case, operating revenues). SFA methods provide an estimate of the mean level and variance of average inefficiency. Estimation of the production function (1) is carried out with Maximum Likelihood and results are expressed in terms of efficiency levels implied by the SFA procedure (*TFP Frontier*).

In the second-step of our analysis, we estimate the impact of State-ownership (*public*) and quality of Government (*QoG*) on TFP[8]:

$$\ln(TFP_{it}) = \gamma_0 + \gamma_1 public_{it} + \gamma_2 QoG + \gamma_3 (public^* QoG) + \gamma_4 \ln(GDP_{it}) + \gamma_5 \ln(TA_{it}) + +\gamma_6 \ln(shareIFA_{it}) + \gamma_7 (REG) + \gamma_8 (COMP) + \delta_i + \zeta_s + \gamma_c + \varepsilon_{it} \quad (2)$$

[8] More specifically, in the case of the Fixed-Effect and LP estimation, we consider as the dependent variable the ratio between firm-level TFP and the average TFP of all firms in the sector (see e.g. Lasagni et al., 2015). The use of such an index allows a clearer comparison with the DEA measure and helps to better characterise TFP which is an 'intrinsically relative concept' (Van Biesebroek, 2008).

controlling for firm's total assets (*TA*) as a proxy for company's size, the per-capita GDP in purchasing power parity (*GDP*) as a proxy for demand,[9] the presence and functioning of an independent regulatory authority (*REG*) and the national industry's competition framework (*COMP*), time (δ_t), sector (ζ_s) and macro-region (γ_c) fixed-effects. The sector fixed-effects distinguish between firms operating in the wired, wireless, satellite and other telecom activities and sub-sectors. Additional firm-level controls include the share of intangible fixed assets, which include R&D capital, over total assets (*shareIFA*) to proxy for the level of innovative activities. Estimation is carried out by means of pooled OLS with standard errors clustered by country and year.

According to the model's specification, the regressor *public* can be either a continuous variable indicating the (log) percentage of shares held by a government or public authority, or a dummy variable, taking value 1 if company *i* is a SIE and 0 otherwise. As mentioned earlier, an enterprise is a SIE if a public body (domestic or foreign) holds at least 10% of its share or is the GUO.

In case of indirect state participations, that is when a given company is in turn held by a State-invested parent company, we adopt the following procedure in order to define the percentage of publicly-owned shares to be assigned to the controlled company. We multiply the percentage of State-owned shares of the parent company by the percentage of shares held in the controlled company and assigned the resulting percentage to the controlled company. For example, Deutsche Telecom, whose 31.7% of shares are State-owned, holds a 59% participation into Magyar Telecom. Therefore, Magyar Telecom is assigned (31.7*59)% = 18.7% of State-owned shares. If, in addition to the indirect State-participation, there is also a direct State-participation, the two participations are summed. For example, Deutsche Telecom holds a 40% participation in O.T.E., which also records a 10% direct participation held by the Government of Greece. Therefore, the % of State-owned shares assigned to O.T.E. is (40*31.7)%+10% = 22.8%.

The use of the continuous variable for public ownership is a step forward with respect to much of the existent literature on the subject, allowing a better understanding of the role of public bodies and governments as owners and investors in hybrid organizations.

4.2. Results

Table 3 shows equation (2) coefficients' estimates when the ownership type is summarised by the (log of) the continuous ownership variable and productivity is computed as the residual of a Cobb-Douglas production function estimated with Fixed-Effects, by means of LP estimation[10] and as the result of SFA. For each dependent variable, in the first column the focus is on the external and institutional variables and their interaction, while in the second column the full set of controls at the firm- and country-level is included.

Public ownership has a negative and significant impact on firms' productivity in almost all of the model specifications (columns 1–6), a result that can be mostly driven by excess employment as found in earlier literature (see Bhaskar and Khan, 1995; Shleifer and Vishny, 1994).

On the contrary, the sign of the QoG indicator is always positive suggesting that the institutional quality of the country in which firms are located exerts a positive effect on their productivity. Moreover, as suggested by the positive and mostly statistically significant sign of the interaction between State-ownership and the QoG indicator, the dampening effect of State-ownership and investment is counterbalanced, to a certain extent, by institutional quality. In other words, while SIEs are on average less efficient in using inputs than their private counterparts, such a gap is reduced by the quality of institutions, summarizing low levels of corruption, high values of law and order and good bureaucracy quality.

At the country-level, per-capita GDP, which summarises the demand conditions firms are facing, is positively and significantly associated to TFP. The variables capturing the country's regulatory framework and competitive environment indicate that, on average the establishment of an independent regulatory authority is negatively associated to firm level TFP, irrespective of the measure considered. This result can be interpreted in the light of the fact that this industry still retains some features of a natural monopoly, and as such presents economies of scale. Thus, forcing competition by the regulators may have initially increased some transaction costs (for example for access to the networks), see Florio (2013) for a discussion of inefficiency of duopoly or oligopoly in general.

Especially in the presence of a public incumbent, the establishment of an independent regulator may, on the one hand, contribute to the decrease in costs due to increased competition by new entrants. On the other, however, it could induce an increase in costs related to the loss of economies of scale and scope. In our dataset, the latter effects might be a possible explanation of the negative coefficient of the regulation variable. A more competitive and liberalized environment, instead, is positively associated to higher levels of productivity, confirming the results of previous literature.[11] At the firm-level, larger enterprises with higher values of Total Assets, and those with a higher share of intangible assets over the total, are those characterised by higher values of productivity.

To further examine the interplay between ownership and institutional quality, the net effect of public ownership is computed for high and low institutional quality countries (Table 4). More in detail, we are considering the effect on our TFP indices of a 10% increase of shares owned by a government or other public bodies, net of the role played by the country's institutional quality.

The *net effect* of public ownership on TFP is computed as:

$$\frac{\partial TFP}{\partial ownership} = \gamma_1 + \gamma_3 {}^{*} QOG\gamma_1\gamma_3$$

[9] Data on GDP is taken from the World Bank dataset.

[10] See note 10.

[11] This result does not hold when considering TFP measured by means of SFA, but it should be noted that, while highly correlated with the other two measures of productivity, this variable is based on a different model.

Table 3
TFP determinants.

	Dep. Variable: TFP CD		Dep. Variable: TFP LP		Dep. Variable: TFP Frontier	
	(1)	(2)	(3)	(4)	(5)	(6)
Public share percentage (ln)	−0.00597	−0.00785*	−0.00553	−0.00876**	−0.00688*	−0.00513**
	(0.0070)	(0.0041)	(0.00750)	(0.0041)	(0.00374)	(0.0023)
Institutional quality	0.172***	0.0550***	0.162***	0.0340*	0.0360**	0.00759
	(0.0336)	(0.0192)	(0.0345)	(0.0189)	(0.0165)	(0.0115)
Public*institutional quality	0.0162*	0.0113*	0.0158	0.0126**	0.0124**	0.00713**
	(0.00915)	(0.0058)	(0.0100)	(0.0057)	(0.00523)	(0.0036)
Per-capita GDP (ln)		0.0291***		0.0281***		0.0197***
		(0.0048)		(0.0048)		(0.0034)
Regulatory authority		−0.00228***		−0.00245***		−0.00153***
		(0.0007)		(0.0007)		(0.0006)
Competition		0.000885*		0.00104**		−0.000577*
		(0.0004)		(0.0005)		(0.0003)
Total Assets (ln)		0.0379***		0.0414***		0.0162***
		(0.0015)		(0.0016)		(0.0009)
Share intangible fixed assets		0.00123***		0.00171***		0.000689***
		(0.0001)		(0.0002)		(0.0001)
Constant	0.688***	0.0883*	0.691***	0.0691	0.0323***	−0.280***
	(0.0230)	(0.0509)	(0.0254)	(0.0519)	(0.0114)	(0.0383)
N	1086	1076	1086	1076	1170	1092
R^2	0.2760	0.7037	0.2528	0.7085	0.2146	0.5831

Pooled OLS estimation. Standard errors in parentheses, clustered by country-year; *p < 0.10, **p < 0.05, ***p < 0.01.
Time, area and sector fixed-effects included.

Table 4
Net Effect of public ownership.

	TFP CD	TFP LP	TFP Frontier
Full sample	−0.0016	−0.0018	−0.0028
High institutional quality	0.0259	0.0289	0.0146
Low institutional quality	−0.0271	−0.0303	−0.0189

Taking the full sample, the net effect of public ownership is negative, confirming the estimated results shown in Table 3.

The result is confirmed when looking at the subsample of countries[12] in the bottom three deciles of the QoG indicator distribution. Whatever the estimation method used to obtain the TFP measure, the net effect of public ownership is negative, albeit small. When looking at the countries in the top three deciles of the QoG indicator distribution[13] the result is reversed: the net effect of public ownership is positive and highly statistically significant suggesting that a good external environment in which the firms operate may actually allow SIEs to outperform private enterprises in terms of TFP measures.

The three graphs in Fig. 1 show that for low levels (bottom 33% of the distribution) of institutions public ownership has a negative impact on productivity; for medium low levels (bottom 66% of the distribution) of institutions public ownership has no impact on productivity; for high levels (top 33% of the distribution) of institutions public ownership has a positive impact on productivity.

4.3. Robustness checks

To test the robustness of our results, public ownership is captured by means of the dichotomous variable taking on value one if a public body is either the firm's GUO or holds at least 10% of its shares and zero otherwise. Previous results are confirmed.[14]

Then, we exclude one macro area at a time to verify whether our results are influenced by characteristics that are common to countries in a homogeneous geographical and institutional space. We thus estimate our model by excluding from the sample, one at a time, China, Centre and South American countries, European States and Middle-East countries. Overall, our results hold, although statistical significance decreases with the diminished sample sizes and hinting towards the importance of macro-regional effects.[15]

Finally, in order to verify the robustness of our results to different aspects of institutional quality, a set of alternative proxies for external institutional quality are considered. The analysis is carried out by considering as the dependent variable TFP measured by

[12] Bangladesh, Bahrain, Bolivia, Brazil, China, Egypt, Guyana, India, Indonesia, Iran, Iraq, Jordan, Kazakhstan, Kenia, Kuwait, Mozambique, Malawi, Nigeria, Oman, Pakistan, Paraguay, Saudi Arabia, Sri Lanka, Senegal, South Africa, Sudan, Suriname, Thailand, Trinidad and Tobago, Venezuela, Vietnam and Zambia.

[13] Austria, Australia, Belgium, Denmark, Finland, France, Germany, Great Britain, Ireland, Island, Japan, Liechtenstein, Luxembourg, Netherland, Norway, New Zealand, Sweden and U.S.A.

[14] The estimation results of these robustness checks are provided in the Appendix A.

[15] Detailed results are available by the authors upon request.

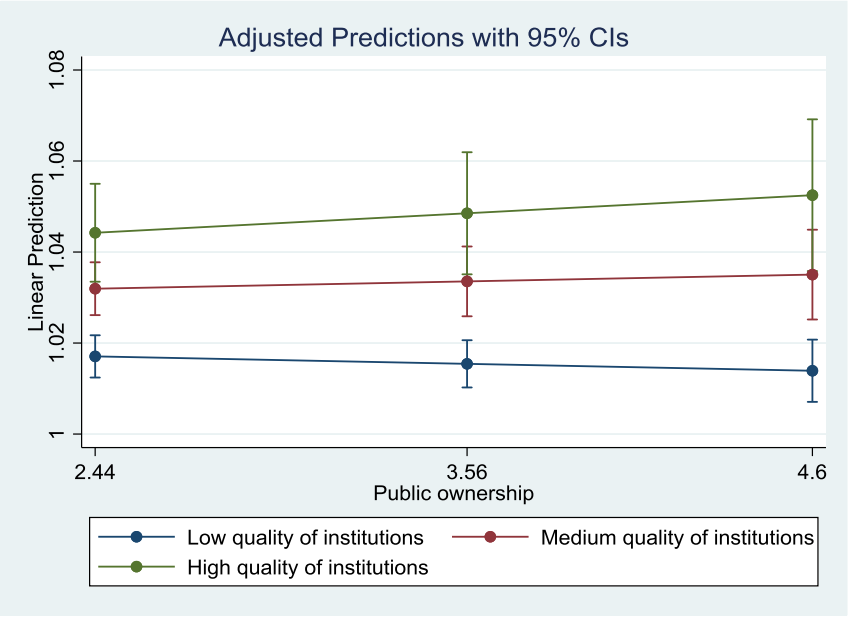

Fig. 1. The effect of ownership at different institutional levels.

means of the LP methodology and by using the continuous public ownership variable.[16] All the institutional variables are standardized as previously explained.

The first index considered is a measure of the perception of corruption provided by Transparency International (*TI_CPI*). The underlying index reports, on a scale between 0 and 100, the perception of corruption in the public sector based on survey administered to experts and businesspeople, with 0 signalling a high level of perceived corruption and 100 no corruption.

Corruption is clearly a relevant dimension to consider when evaluating the existence of distorting incentives of managers in publicly owned or controlled firms. Empirical results (Table 5, columns 1 and 2) are qualitatively similar to those presented in Table 3, although only the institutional variable in levels is statistically significant.

Two other measures are instead taken from the World Economic Forum databank and are related to the diversion of public funds (*WEF_DPF*) and trust in politicians (*WEF_PTP*). The underlying indices are based on surveys administered to experts and are on a 1 to 7 scale, with 1 being "very common" and 7 "never occurs".

Both measures are highly correlated with the perception of corruption, as the previous indicator, but with a more nuanced flavour. Again, a country perceived to be run by politicians who are not trustworthy or where public funds are thought to be diverted from the social welfare to private benefit for public administrators or politicians might present an unfavourable institutional environment for well-managed and efficient public firms. Results (Table 5, columns 3 through 6) again support previous findings.

Finally, the Fraser Institute indicator for legal system and security of property rights (FI_LEGPROP) captures rule of law, security of property rights, an independent and unbiased judiciary, and impartial and effective enforcement of the law. The index goes from 0 to 10, with increasing values indicating better institutional quality. Results (Table 5, columns 7 and 8) once again confirm previous findings.

Overall, the use of alternative indices for institutional quality has not altered the coefficients' sign and statistical significance of the controls and has confirmed our results related to the main variables of interest (ownership and external institutional quality), both when considering ownership as a continuous variable (Table 5) or as a dichotomous variable (Table A3).

5. Conclusions

In this paper we investigated the role played by internal and external institutions, along with their interaction, as determinants of total factor productivity of firms operating in the telecommunications sector. In our framework, ownership is the relevant internal institution, while a synthetic measure of government quality is taken as a proxy for the external institutional environment.

Using financial and ownership data from the Orbis database we built a sample of about 350 companies which includes firms from 90 different countries belonging to seven macro-areas (Africa, Asia, Europe, Middle East, North-America, Oceania and Centre-South-America) and covers the years from 2007 to 2015. Country-level information on institutional quality is obtained from the Quality of Government Social Policy Dataset. ITU data were used to consider industry regulation and competition at country level.

The results of the econometric analysis reveal that indeed a productivity gap exists between State-invested and private enterprises,

[16] Results based on the other two measures are qualitatively similar and are available by the authors upon request while the table with ownership as a dichotomous variable is presented in the Appendix A.

Table 5
Alternative institutional indicators.

Dep. Variable: TFP (LP)	TI_CPI		WEF_DPF		WEF_PTP		FI_LEGPROP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public share percentage (ln)	0.000378	−0.00391	−0.00694	−0.00543**	−0.0122***	−0.00508**	−0.01323**	−0.00673**
	(.0045)	(0.0026)	(.0042)	(0.0023)	(0.0038)	(0.0021)	(0.0055)	(0.0031)
Institutional quality	0.16180***	0.0281**	0.1122***	0.0333***	0.06693***	0.0171	0.1372***	0.0162
	(.0071)	(0.0130)	(0.0241)	(0.0115)	(0.0239)	(0.0109)	(0.0334)	(0.0199)
Public*institutional quality	0.00642	0.00618	0.01851***	0.00947**	0.02989***	0.00943**	0.02689***	0.0107**
	(.0071)	(0.0042)	(0.0070)	(0.0041)	(0.0078)	(0.0041)	(0.0087)	(0.0051)
Per-capita GDP (log)		0.0283***		0.0222***		0.0254***		(0.00612)
		(0.0047)		(0.0050)		(0.0054)		
Regulatory authority		−0.00282***		−0.00372***		−0.00385***		−0.00371***
		(0.0007)		(0.0006)		(0.0006)		(0.000639)
Competition		0.00129***		0.00170***		0.00191***		0.00180***
		(0.0005)		(0.0005)		(0.0005)		(0.0005)
Total Assets (ln)		0.0413***		0.0419***		0.0418***		0.0419***
		(0.0016)		(0.0016)		(0.0016)		(0.0016)
Share intangible fixed assets		0.00168***		0.00168***		0.00172***		0.00175***
		(0.0002)		(0.0002)		(0.0002)		(0.0002)
Constant	0.68339***	0.0735	0.73304***	0.147**	0.74588***	0.121*	0.70983***	0.107*
	(0.0235)	(0.0516)	(0.0201)	(0.0576)	(0.0199)	(0.0618)	(0.0246)	(0.0627)
N	1096	1086	959	952	959	952	957	950
R^2	0.2735	0.712	0.282	0.722	0.288	0.721	0.288	0.719

Pooled OLS estimation. Standard errors in parentheses, clustered by country-year; *p < 0.10, **p < 0.05, ***p < 0.01.
Time, area and sector fixed-effects included.

confirming earlier results in the empirical literature. Such literature has interpreted this gap in terms of intrinsic inefficiency of public enterprises, consistently with theoretical views in such strands such as property rights theory or public choice.

Our research question focuses instead on understanding the interplay between institutional quality and ownership on firm level productivity. This research question stems from the increasing interest in the economics literature on the role of institutions and blends it with the insights from the literature on the determinants of productivity at the micro level.

A further advancement with respect to previous findings is that we considered public ownership in terms of a continuous variable summarizing the percentage of share held by public bodies, thus going beyond the traditional dichotomy of public or private ownership.

Our findings are simple and clear: we can reject the hypothesis that the quality of institutions has the same effect on public and private enterprises in the telecommunications industry. This effect, albeit small in size, is different, and it is such that in countries with good quality of institutions the productivity gap between public and private enterprises is mitigated or actually reversed. Our findings also suggest that the regulatory environment, as summarised by the establishment of an independent regulatory body and the competitive framework in which firms, both private and public operate, are related to firm-level productivity.

In terms of policy implications, our results are suggestive of the importance of external, contour conditions (such as institutional quality and the regulatory and competitive environment at the country level) in terms of productivity of private and public firms, thus possibly representing conditioning factors which may help determine the success of a privatization process. Privatised firms will not necessarily perform better than public firms in countries where the external institutional environment is such that, e.g., anti-competitive forces are at play, corruption and interest groups alter the allocation of previously state-owned firms to private parties, the regulator is not independent and so on. At the same time, public firms can perform just as well, in terms of profit maximization and productivity levels as private firms in contexts where the rule of law and control of government activities is solid, regulatory bodies are not prone to capture, competition from both private and public competitors is not hindered, and the overall external environment is favourable.

While further research is needed to fully corroborate this intuition, this line of reasoning is in the tradition of Laffont (2005). In his posthumous book on regulation and development, Laffont (2005) suggested that privatization policies may occur for quite different reasons. In less developed countries policy-makers may have a private agenda, regulators risk to be corrupted, and ex-post evaluation is costly. In such circumstances corrupted governments may divest SOEs to shift control of public assets to cronies. Governments with an intermediate degree of corruption may also privatize SOEs, but not always for good reasons in terms of social welfare. According to Laffont (2005) privatization is undesirable when the private benefit/cost ratio of the policy-makers exceeds the social value of divestiture. Under benevolent government, or at least when the democratic system of checks and balances and the rule of law ensure public accountability and low corruption, privatization may or may not be desirable, according to a case-by-case social cost-benefit analysis of its welfare impact. Such analysis may provide different results according to the industry, the country, and the timing, as suggested by Jones et al. (1990) or Florio (2003, 2013).

Our empirical findings confirm that a comparison of the merits of public versus private ownership should include the consideration of the institutional, regulatory and competitive context in place or actually achievable, as such context interacts with ownership of firms. In other words, any policy analysis of privatization should take a broader institutional perspective. When full competition cannot be achieved, as in many network industries, it seems of paramount importance to ensure that regulators are nor captured by the privatised incumbent. When the regulator is honest and transparent, competition -as far as possible- is fair, and consumers are protected by market dominance, then the performance of state-owned enterprises may be aligned with that of their private competitors.

Appendix A

Table A1
Firms' distribution by country and ownership type.

Geographical Macro-Area	N° of Firms	SOEs and SIEs	Private firms
Africa			
Egypt	4	3	1
Kenia	1	1	0
Morocco	1	1	0
Nigeria	1	0	1
Senegal	1	1	0
Sudan	1	1	0
South Africa	4	1	3
Zambia	1	1	0
Asia			
Bangladesh	1	1	0
Japan	9	5	4
Republic of Korea	3	1	2
Taiwan	1	1	0
Vietnam	7	5	2
Thailand	10	4	6
Russian Federation	6	3	3
Malaysia	2	2	0
Philippines	5	2	3
Pakistan	1	1	0
Kazakhstan	1	1	0

(*continued on next page*)

Table A1 (*continued*)

Geographical Macro-Area	N° of Firms	SOEs and SIEs	Private firms
Sri Lanka	2	2	0
Hong Kong	4	2	2
Indonesia	8	5	3
India	4	3	1
China	7	7	0
Centre- and South-America			
Barbados	1	0	1
Bermuda	2	0	2
Bolivia	3	1	2
Brasil	9	0	9
Bahamas	1	1	0
Belize	1	1	0
Chile	2	0	2
Guyana	1	0	1
Jamaica	1	0	1
Cayman Island	4	0	4
Mexico	4	0	4
Paraguay	3	1	2
Suriname	1	1	0
Trinidad and Tobago	1	1	0
Urugay	1	1	0
Venezuela	1	1	0
Europe			
Austria	8	3	5
Belgium	9	3	6
Bosnia and Herzegovina	3	3	0
Bulgaria	4	2	2
Croatia	4	2	2
Cyprus	2	1	1
Czech Republic	5	1	4
Denmark	4	2	2
Estonia	3	1	2
Finland	4	1	3
France	9	2	7
Germany	6	1	5
Great Britain	11	0	11
Greece	7	3	4
Hungary	6	1	5
Iceland	1	0	1
Ireland	8	1	7
Italy	6	1	5
Kosovo	1	1	0
Latvia	4	3	1
Liecthestain	1	1	0
Lituania	6	3	3
Luxembourg	7	2	5
Macedonia	1	1	0
Malta	4	1	3
Netherlands	10	2	8
Norway	3	3	0
Poland	3	0	3
Portugal	6	0	6
Romania	8	4	4
Serbia	4	3	1
Slovakia	4	2	2
Slovenia	2	2	0
Spain	6	2	4
Sweden	14	8	6
Switzerland	2	1	1
Ukraine	4	2	2
Middle East			
United Arab Emirates	2	2	0
Baharain	2	2	0
Israel	8	0	8
Iraq	1	1	0
Iran	1	1	0
Jordan	2	2	0
Kuwait	2	1	1
Oman	2	2	0
Qatar	2	1	1

(*continued on next page*)

Table A1 (*continued*)

Geographical Macro-Area	N° of Firms	SOEs and SIEs	Private firms
Saudi Arabia	3	2	1
North-America			
Unites States	9	1	8
Oceania			
Australia	4	0	4
New Zealand	1	0	1
Total	**348**	**144**	**204**

Source: Orbis, authors' elaboration.

Table A2
Ownership as a 0/1 indicator variable.

	TFP CD		TFP LP		TFP Frontier	
	(1)	(2)	(3)	(4)	(5)	(6)
Public	−0.0464*	−0.0261*	−0.0473*	−0.0300*	−0.0437***	−0.0232***
	(0.0255)	(0.0155)	(0.0272)	(0.0154)	(0.0132)	(0.0085)
Institutional quality	0.157***	0.0561***	0.145***	0.0354*	0.0240	0.00691
	(0.0342)	(0.0191)	(0.0349)	(0.0189)	(0.0165)	(0.0110)
Public*institutional quality	0.0912***	0.0371*	0.0928**	0.0422**	0.0680***	0.0321**
	(0.0332)	(0.0219)	(0.0359)	(0.0214)	(0.0185)	(0.0133)
Regulatory authority		−0.00252***		−0.00265***		−0.00164***
		(0.0007)		(0.0007)		(0.0005)
Competition		0.000915**		0.00108**		−0.000557*
		(0.0004)		(0.0004)		(0.0003)
Per-capita GDP (log)		0.0285***		0.0272***		0.0178***
		(0.0046)		(0.0048)		(0.0032)
Total Assets (ln)		0.0378***		0.0414***		0.0162***
		(0.0015)		(0.0158)		(0.0009)
Share intangible fixed assets		0.00122***		0.00169***		0.000690***
		(0.0001)		(0.0002)		(0.0001)
Constant	0.697***	0.0976*	0.700***	0.0789	0.0383***	−0.260***
	(0.0229)	(0.0499)	(0.0252)	(0.0509)	(0.0111)	(0.0363)
N	1095	1085	1095	1085	1185	1103
R2	0.2750	0.7025	0.2518	0.7073	0.2210	0.5841

Pooled OLS estimation. Standard errors in parentheses, clustered by country-year; *p < 0.10, **p < 0.05, ***p < 0.01.
Time, area and sector fixed-effects included.

Table A3
Alternative institutional indicators (Ownership as a 0/1 indicator variable).

Dep. Variable: TFP (LP)	TI_CPI		WEF_DPF		WEF_PTP		FI_LEGPROP	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Public	−0.01064	−0.0116	−0.03061**	−0.0158*	−0.04535***	−0.0167**	−0.05580***	−0.0160
	(0.0168)	(0.0094)	(0.0155)	(0.00842)	(0.0141)	(0.0078)	(0.0207)	(0.0115)
Institutional quality	0.15277***	0.0302**	0.10837***	0.0346***	0.06534***	0.0175	0.13221***	0.0211
	(0.0281)	(0.0132)	(0.0246)	(0.0119)	(0.0245)	(0.0111)	(0.0339)	(0.0199)
Public*institutional quality	0.0433	0.0171	0.07846***	0.0277*	0.1163***	0.0326**	0.11204***	0.0244
	(0.0265)	(0.0156)	(0.0261)	(0.0151)	(0.0296)	(0.0157)	(0.0326)	(0.0188)
Per-capita GDP (log)		0.0277***		0.0228***		0.0255***		0.0274***
		(0.00474)		(0.0049)		(0.0054)		(0.0062)
Regulatory authority		−0.00302***		−0.00379***		−0.00395***		−0.00384***
		(0.0007)		(0.0006)		(0.0006)		(0.0006)
Competition		0.00134***		0.00175***		0.00195***		0.00185***
		(0.0005)		(0.0005)		(0.0005)		(0.0005)
Total Assets (ln)		0.0413***		0.0419***		0.0418***		0.0419***
		(0.00157)		(0.0016)		(0.0016)		(0.0016)
Share intangible fixed assets		0.00167***		0.00167***		0.00172***		0.00173***
		(0.0002)		(0.000174)		(0.0002)		(0.0002)
Constant	0.6886***	0.0800	0.7350***	0.141**	0.74639***	0.121*	0.71252***	0.0980
	(0.0233)	(0.0512)	(0.0200)	(0.0571)	(0.0198)	(0.0614)	(0.02446)	(0.0629)
N	1105	1095	965	958	965	958	963	956
R^2	0.272	0,710	0.281	0.722	0.278	0.721	0.286	0.718

Pooled OLS estimation. Standard errors in parentheses, clustered by country-year; *p < 0.10, **p < 0.05, ***p < 0.01.
Time, area and sector fixed-effects included.

Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejpoleco.2018.10.005.

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