

Di Pillo, Francesca; Levialdi Ghiron, Nathan; Marchegiani, Laura

Article

The investments in energy distribution networks : does company ownership matter?

Provided in Cooperation with:

International Journal of Energy Economics and Policy (IJEPP)

Reference: Di Pillo, Francesca/Levialdi Ghiron, Nathan et. al. (2020). The investments in energy distribution networks : does company ownership matter?. In: International Journal of Energy Economics and Policy 10 (5), S. 41 - 49.

<https://www.econjournals.com/index.php/ijeep/article/download/9511/5257>.

doi:10.32479/ijeep.9511.

This Version is available at:

<http://hdl.handle.net/11159/8458>

Kontakt/Contact

ZBW – Leibniz-Informationszentrum Wirtschaft/Leibniz Information Centre for Economics

Düsternbrooker Weg 120

24105 Kiel (Germany)

E-Mail: [rights\[at\]zbw.eu](mailto:rights[at]zbw.eu)

<https://www.zbw.eu/econis-archiv/>

Standard-Nutzungsbedingungen:

Dieses Dokument darf zu eigenen wissenschaftlichen Zwecken und zum Privatgebrauch gespeichert und kopiert werden. Sie dürfen dieses Dokument nicht für öffentliche oder kommerzielle Zwecke vervielfältigen, öffentlich ausstellen, aufführen, vertreiben oder anderweitig nutzen. Sofern für das Dokument eine Open-Content-Lizenz verwendet wurde, so gelten abweichend von diesen Nutzungsbedingungen die in der Lizenz gewährten Nutzungsrechte.

<https://zbw.eu/econis-archiv/terms-of-use>

Terms of use:

This document may be saved and copied for your personal and scholarly purposes. You are not to copy it for public or commercial purposes, to exhibit the document in public, to perform, distribute or otherwise use the document in public. If the document is made available under a Creative Commons Licence you may exercise further usage rights as specified in the licence.



The Investments in Energy Distribution Networks: Does Company Ownership Matter?

Francesca Di Pillo^{1*}, Nathan Levialdi¹, Laura Marchegiani²

¹Department of Enterprise Engineering, University of Rome Tor Vergata, Via del Politecnico 1, 00133, Rome, Italy, ²ARERA, the Italian Regulatory Authority for Energy, Networks and Environment, Via di Santa Maria in Via 12, 00187, Rome, Italy.

*Email: dipillo@dii.uniroma2.it

Received: 27 February 2020

Accepted: 02 June 2020

DOI: <https://doi.org/10.32479/ijee.9511>

ABSTRACT

This paper revolves around the challenges currently tackled by the energy distribution sector, where infrastructural investments play a vital role in both increasing the industry's internal efficiency and developing national economies. In natural gas and electricity sectors, the liberalisation process began in Europe at the end of the 1990s has triggered a change in the industry's competitive framework, encouraging investments by companies aiming at improving their industrial and organisational efficiency. At the same time, liberalisation also brought about a change in the ownership of firms: Private and mixed ownership companies are now actively participating in the market, together with state-owned enterprises. In the light of these significant changes, this study is aimed at establishing whether the companies' propensity to invest in infrastructures is connected with a specific form of ownership. So far, this specific topic has not been thoroughly investigated by empirical studies; this work tries to fill this gap by carrying out an empirical analysis on a sample of Italian energy distribution utilities operating in the natural gas and electricity sector.

Keywords: Infrastructure Investments, Energy Distribution Sector, Private And Public Companies, Mixed Companies

JEL Classifications: L94, L95, L97, L98, Q48

1. INTRODUCTION

Over the last few years, the industry of energy distribution utilities has radically changed, after having tackled several challenges, such as the regulation and transformation of the supply chain's various stages (unbundling) and, at the same time, an increasing tendency to concentration (such as mergers, acquisitions, and sell-offs of company branches). This has encouraged new investments, aimed at recovering industrial and organisational efficiency. This article focuses on investments by local energy distribution utilities. Indeed, the decision to invest in the energy distribution sector is a particularly sensitive one from the point of view of management: Infrastructures for energy transportation and distribution rely on a complex sub-system, which, in its turn, involves key social and technical aspects, requires the participation of institutions, and must ensure compliance with social and environmental goals (Bolton and Foxon, 2015).

This study analyses a sample of Italian energy distribution utilities operating in the natural gas and electricity sector. In Italy, the technological innovation of energy distribution utilities has always played a marginal role, owing to a variety of reasons. First, energy distribution used to be managed under a local monopoly system, which is intrinsically connected with a low propensity to change. In addition, the fragmentation of the sector and the average small size of the companies did not create the right conditions for providing effective support to innovation processes. In the 2000s, the liberalisation of the natural gas and electricity sectors brought about new development goals, prompted a radical change of technological policies, and required massive investments in infrastructures. The emergence of competition contributed to speeding up technological innovation processes, especially in those stages of the supply chain characterised by the presence of infrastructural networks.

A change in the ownership of companies operating in the energy sector occurred at the same time as liberalisation and the changes it brought about. In the energy sector, before liberalisation, the provision of natural gas and electricity used to be managed by enterprises owned by local governments (known as “municipal companies”). After liberalisation took place, private or mixed ownership companies fully entered the energy market. In general, the privatisation of public utilities is aimed both at improving the production efficiency and at encouraging investments, via private investors’ capitals. In literature, several schools of thought have proved the existence of a positive relationship between private ownership and performance in terms of production and/or profits. As for common agency literature is concerned, Laffont and Tirole (1991) have investigated the issue of incentives, showing that in companies owned by private stakeholders more effort is put into improving efficiency and profitability than in enterprises owned by the state. In the framework of property rights theory, several authors have shown that private company managers pursue greater efficiency in terms of production, because their main aim is to reduce costs (Alchian and Demsetz, 1972; Demsetz, 1988; Grossman and Hart 1986). Regarding empirical research carried out in the field of management studies, several works have proved the existence of a positive relation between private ownership and performance (Andrews and Dowling 1998; Boycko et al., 1996; Megginson and Netter, 2001; Wang and Shailer, 2018; Yarrow, 1986).

The relationship between the companies’ form of ownership and their propensity to invest was investigated only by a branch of literature - that is, property rights theory -, which has shown the superiority of private ownership (Grossman and Hart, 1986; Hart and Moore, 1999). Regarding empirical management studies, according to our knowledge, the relationship between the companies’ form of ownership and their propensity to invest has barely been investigated. This work is aimed at filling this gap, since the debate on the ownership of public services mainly revolves around the companies’ propensity to invest in infrastructural technology.

Increasing investments and promoting innovation are very important goals in the energy distribution market, which, structurally, requires significant investments to support the maintenance and renewal of network infrastructure. This is the reason why the distribution segment - in particular, the natural gas and electricity segment - of the supply chain has been chosen as the specific object of this study.

Based on these considerations, this work aims at assessing the impact of distribution companies’ form of ownership on infrastructural investments via a multiple regression analysis. To avoid any bias in the outcomes of the study, the analysis has included variables regarding company size. The econometric model considers, as investment drivers: Private, public and mixed private-public forms of ownership. This last company form characterises companies set up since the 1990s, in almost all European countries (including Italy), because the privatisation of public local utilities was only “partial”: Indeed, governments have only privatised a minority stake of state-owned enterprises (Bel and Fageda, 2009). Initially, mixed ownership was mainly considered a temporary

phase, before the actual and complete privatisation of utilities. However, since the late 1990s, international institutions, policy makers, and scholars gradually recognized mixed ownership as a separate model, capable of lessening market and state failures in the provision of public services at the local level (Monteduro, 2014).

This paper is structured as follows: Section 2 describes the theoretical background of company ownership in the framework of privatisation of energy distribution utilities. Section 3 provides an overview of the Italian situation, while section 4 illustrates the framework of investments in the natural gas and electricity sector carried out by Italian energy distribution companies. Section 5 explains the methodology and data underlying this study; section 6 is devoted to the analysis of the study’s results. Section 7 analyses the study’s key findings and their implications for policy makers. Finally, section 8 is devoted to conclusions and suggestions for future research.

2. PRIVATISATION OF ENERGY SERVICES: THEORETICAL BACKGROUND

2.1. Private Versus Public Ownership Companies

The privatisation of public utilities has been a widely debated issue at the international level, drawing the attention of policy makers and scholars all around the world (Bortolotti et al., 2004; Estrin et al., 2009; Megginson and Netter 2001; Peters, 2012; Price, 2007; Villalonga, 2000). The debate, which has involved several political and academic stakeholders, has revolved around two opposing arguments: On the one hand, supporters of privatisation see it as a solution to budget constraints and a remedy for poor performance by enterprises owned by the state (Andrews and Dowling, 1998; Boycko et al., 1996; Yarrow, 1986). On the other hand, critics of privatisation emphasise the need of the “public hand” in managing public utilities. According to them, the rationale for public ownership is rooted in the inevitable risk of market failure and, due to the nature of public utilities, it is the government’s duty to ensure that essential services are adequately provided to the entire population and at a reasonable cost (Grout and Stevens, 2003; Moe, 1987).

Regarding investment incentives, the prevalence of one form of ownership (public or private) over the other often depends on the specific goals of investments. Indeed, a large branch of the literature of economics based on the theory of property rights (more specifically, the GHM theory by Grossman, Hart and Moore, also known as “property rights theory”) takes into consideration two main types of investment incentives: Those aimed at reducing costs and those aimed at improving quality (Grossman and Hart, 1986; Hart and Moore, 1999; Shleifer, 1998). With public ownership, the managers’ motivation to make either type of investment is relatively weak: Indeed, managers do not actually own any company share and they only get a small fraction of revenues as a return on investments. On the contrary, private company managers are much more motivated to invest, because the company’s shareholders get a larger share of the ROI. The lack of motivation by government employees to reduce costs, improve quality, and bring about innovation seems to prove the

superiority of the private ownership model, as confirmed by a wide range of empirical studies and by general observation (Barberis et al., 1996; Ehrlich et al., 1994). However, the GHM theory has shown that even privatisation should be limited: Private managers may tend to reduce costs at the expense of quality. Indeed, if the quality of services is difficult to specify in a contract, the asset's private owners may be motivated to reduce costs even if this means reducing quality. On the contrary, public ownership mitigates any incentive to cut costs at the expense of quality, since profit is not the ultimate goal.

2.2. Mixed Companies

Investments in infrastructure, although historically dominated by public intervention, are increasingly managed through public-private partnerships (PPP) (Somma and Rubino, 2016). Furthermore, the recent economic and financial crisis and the limitations of public resources brought about renewed interest in PPP (Rossi et al., 2019). Most authors have pointed out that this alternative governance model allows to mitigate the negative consequences of market failure when providing public services at the local level (Matsumura and Kanda, 2005; Monteduro, 2014).

The creation of mixed ownership companies allows to channel the private sector's skills and resources into state-owned enterprises, thus generating benefits in terms of efficiency. Several authors have proved that mixed ownership companies have much better performance indicators than enterprises fully owned by the state (Bel and Fageda, 2010; Bognetti and Robotti, 2007). Furthermore, Garrone et al. (2011) have analysed a sample of multiutilities and proved that there is a relationship between cost reduction and the presence of private shareholders. Similarly, Menozzi and Vannoni (2011) have analysed a sample of companies operating in the gas, water, and electricity sectors and shown that the main performance indicators improve in mixed ownership utilities.

As for investment incentives are concerned, since in mixed public-private ownership companies no stakeholder has veto power, both types of innovation (those aimed at reducing costs and those aimed at improving quality) are expected to be carried out. In literature, there is only one study comparing state-owned enterprises and private companies in terms of propensity to invest. The study was carried out by Schmitz (2001) and shows that mixed companies tend to offer better incentives in terms of cost reduction than fully state-owned enterprises and, at the same time, encourage quality improvement to a greater extent than fully private companies.

Our study is aimed at filling this gap in literature, by analysing the propensity to invest of mixed companies in the energy distribution utility sector, which is still undergoing a deep transformation process.

3. ENERGY DISTRIBUTION SECTOR IN ITALY

Traditionally, since local energy distribution is a network-based industry, it has generally been managed in natural monopoly conditions. In the 1980s and early 1990s, local governments used

to manage local distribution services, either directly or through specific agencies. However, after the system was reformed in the late 1990s, a progressive tendency to increased competition became apparent (Bognetti and Robotti, 2007).

The set of rules and regulations regarding natural gas distribution was reformed by Legislative Decree n.164/2000 (also known as "Decreto Letta"), which established the key principles of market liberalisation (Ministry of Economic Development, 2000). In particular, this decree provides for local governments to award distribution contracts via a public tendering procedure, while in the past such contracts were almost always awarded directly. Given the monopolistic nature of the services, competition is primarily "for" the market: Companies compete in a public tendering procedure to gain the right to provide markets with services over a specific period. Later, Legislative Decree n°159/2007, converted into Law N°222/2007, introduced an innovative principle, which had huge impact on the sector: Public tenders for the awarding of gas distribution services would be based on administrative divisions called "ATEM" (*Ambiti Territoriali Minimi*, literally "minimum local areas"), which do not coincide with individual municipalities. These ATEMs were identified according to Ministerial Decree of January 19, 2011, which established 177 divisions for the distribution of natural gas. The ATEMs were established based on the need to develop distribution services efficiently, reduce costs for final clients, and remove the barriers which hindered competition in the gas sale sector.

After the sector reforms, the structure of the gas distribution market has changed significantly. More specifically, a concentration process has occurred, after the consolidation and merging of previous "municipal companies" and takeovers of private companies. This concentration process was due, among other causes, to a tendency to consolidation which was under way in the gas sale phase at the same time (Capece et al., 2009; 2013). Besides, some Italian enterprises in the electricity sector and key European operators entered the market via the takeover of national companies: This was one of the most significant changes in the distribution market.

Another sign of the industry's reorganisation process which has occurred in the last 10 years is the change in the number of operators: If the number of distributors amounted to 308 in 2009, in 2016 this figure was already down to 219 (ARERA, 2017). This change is due to merging and takeover processes involving several companies (and to the sell-off of branches or plants), bringing about a natural reduction in the number of companies operating in the sector.

As for ownership is concerned, in 2016 (last year for which data are available), 32.3% of distribution companies were still owned by local governments (Table 1), although their role in the sector has deeply changed. Local governments have ceased to manage distribution services directly: Distribution is now mostly carried out by business entities where local government bodies have significant control or companies fully owned by private shareholders. In total, the shares owned by energy companies amounted to 29.8% (ARERA, 2017).

The regulatory and institutional framework of electricity distribution sector was deeply changed by the enforcement of legislative decree n. 79 of March 16, 1999 (also known as “Bersani Decree”), the Italian transposition of EU Directive 96/92 on the liberalisation of the electricity sector (Ministry of Economic Development, 1999). One of the main consequences of the Italian electricity industry’s reorganisation was the emergence of a clear distinction between individual production phases: While electricity generation, import, export and sales have been liberalised because they are potentially competitive, transmission remains under the state’s monopoly. Since distribution is a natural monopoly, it is carried out based on concessions granted by the Ministry of Economic Development, according to the principle of competition “for” the market. Public tendering procedures for the granting of distribution concessions are aimed at identifying a company which will be responsible for the management, maintenance, and development of networks and related interconnection devices.

The sector reforms and the functional unbundling of production/sale companies from distribution companies have modified the market’s context. In particular, several consolidation operations have been carried out. Indeed, for many enterprises, the need to comply with the new unbundling rules has been a driver for consolidation: The entire group’s distribution activities have often been pooled and assigned to a single subject, whose business name is different from the name of the group’s companies devoted to sales. In other cases, functional unbundling has translated simply into a change of company name. Besides, several activities or branches have been sold off/taken over. According to the latest data made available by the ARERA registry of operators, after these consolidation processes the number of electricity distributors amounted to 135 in 2016. Moreover, the distribution industry is extremely concentrated: 93% of electric energy volumes is distributed by the three largest operators.

As for the ownership of distribution operators (Table 2) is concerned, companies led by physical persons prevail (41%),

followed by enterprises led by state authorities (37.4%). A large number of shares is owned by national and local energy companies (respectively, 6.7% and 5.5%).

4. INVESTMENTS IN THE ITALIAN GAS AND ELECTRICITY DISTRIBUTION NETWORKS

Energy distribution companies provide essential services to society at large. As the need for a change towards a more sustainable society is increasingly being recognized, these companies now require structural improvement (Loorbach et al., 2010). Distribution companies have adjusted their business strategies according to the industry’s rapid pace of change, focusing on infrastructural investments and technological innovation. However, it should be underlined that technological progress has always taken place at different times and in different ways in specific areas of the energy sector.

In the electricity sector, the regulatory framework has been successful in attracting significant investments, which are necessary to update electricity networks, encourage managers to adopt efficient strategies, and improve the quality of distribution services. In the electricity distribution sector, investments have had two main goals: The inclusion of renewable sources of energy and the achievement of energy efficiency. To this end, smart grid solutions have been adopted to make the system more flexible, thus favouring decentralised generation of electricity and energy efficiency. Furthermore, these systems are aimed at emergence of active consumers who want to independently manage their power consumption (Mekhdiev et al., 2018).

Investments in smart grids are on the rise all over Europe. According to a study recently carried out across 20 countries in Western Europe, businesses will invest USD 133.7 billion in smart grid infrastructures in the decade between 2017 and 2027. Such estimate is the result of policies aimed at meeting the goals set by the European Commission, regarding the installation of smart (new-generation) meters in 80% of European households.

In Italy, the first - and most important - step towards the creation of smart networks was the introduction of smart measurement, via the implementation of digital communication systems. Thanks to smart meters, users receive information allowing to regulate consumption; at the same time, sellers are able to monitor the network’s conditions, identify any issues (e.g. voltage deficit or overloads), and offer diversified services, thanks to the dynamic knowledge of their clients’ consumption. Another application of smart networks is the inclusion of renewable energy into the system, which helps achieve the environmental sustainability goals set by the European Union.

In the gas distribution and metering sector, the main technological investments have been made into network monitoring, management, and optimisation projects. Furthermore, to comply with the obligations as per the ARERA ARG/gas 155/08 Resolution, significant investments have been made into the updating of

Table 1: Share capital of gas distribution companies

Kinds of shareholders	2015 (%)	2016 (%)
Local governments	34.2	32.3
Different companies	25.0	24.9
National energy companies	13.9	16.4
Local energy companies	12.8	13.0
Natural persons	13.2	12.7
Foreign energy companies	0.6	0.6
Stock market	0.2	—
National financial institutions	0.1	0.1

Source: ARERA, 2017

Table 2: Share capital of electric energy distribution companies

Kinds of shareholders	2015 (%)	2016 (%)
Natural persons	40.0	40.7
Local governments	39.2	37.4
Different companies	8.8	9.5
National energy companies	5.8	6.7
Local energy companies	5.6	5.5
Stock market	0.4	—
National financial institutions	0.2	0.2

Source: ARERA, 2017li

obsolete meters and the installation of digital meters for remote reading (ARERA, 2008). Indeed, metering has always been a key element for the transformation of the gas market into a fully deregulated industry. The current subdivision of the operators' roles, generated by the implementation of legislative decree 164/2000, has brought about a significant increase in management issues regarding metering data. Indeed, while originally distribution companies also played the role of sellers, with the advent of liberalisation each distributor started to work with several sellers working on their networks. As the number of sellers working with distributors increased, the metering process and related meter reading have become critical aspects of energy distribution. These aspects are to be correctly supported from the technological point of view, to allow excellent allocation of gas supplies to various gas sale companies.

Finally, many distribution companies made investments in the gas network to comply with SEN 2017 requirements (*Strategia Energetica Nazionale*, literally "National Energy Strategy"), a national strategy mainly aimed at "making the production system more sustainable, both from the environmental and the competitive point of view." To this end, several investments have been made to improve energy efficiency: Remote monitoring of pipelines, real-time detection of leaks, implementation of technological platforms supporting the networks' maintenance and monitoring activities in real time.

The Figure 1 shows the amounts of investments made by the investigated sample of companies. As for the electricity distribution sector is concerned, most investments were made into low and medium voltage plants (7.9 and 7.6 billion respectively). In the gas sector, investments were made mainly into distribution plants, amounting to approximately 5.3 billion.

5. DATA AND METHODS

The sample chosen for the analysis consists of the companies for which there is an obligation to transmit their unbundling data to the Authority. The declaration of accounting unbundling data is aimed at ensuring a reliable and detailed flow of data regarding the economic components and assets of companies dealing with the activities regulated by the Authority. Unbundling data are declared via the so-called CAS (*Conti Annuali Separati*, literally "Separate Annual Accounting"), drafted according to the rules

of accounting separation (or accounting unbundling). In Italy, there are approximately 200 energy distribution utilities under the obligation to declare their unbundling data. Our sample accounts for 30% of them in terms of number of companies (34 gas distribution companies and 25 electric energy distribution companies). Since distribution is a concentrated sector, it must be pointed out that the gas sector sample accounts for 63% of volumes distributed over the entire market, while the electricity sample accounts for 98.5%.

Each company's form of ownership (fully owned by the state, fully owned by private stakeholders, or mixed) has been identified. More in detail, 34 gas distribution companies have been investigated, including: 8 enterprises fully owned by the state, 5 companies fully owned by private stakeholders and 21 mixed public-private ownership companies. In the electricity distribution sector, 25 companies have been investigated, including: 6 enterprises fully owned by the state, 8 companies fully owned by private stakeholders and 11 mixed public-private ownership companies.

Regarding investments, the unbundling data declared by companies have been taken into consideration. In the gas sector, the sum of investments into derivation and connection plants has been taken into consideration, while in the electricity sector only distribution plants were considered, based on the sum of individual investments made into low (LV), medium (MV) and high (HV) voltage (EHV) plants.

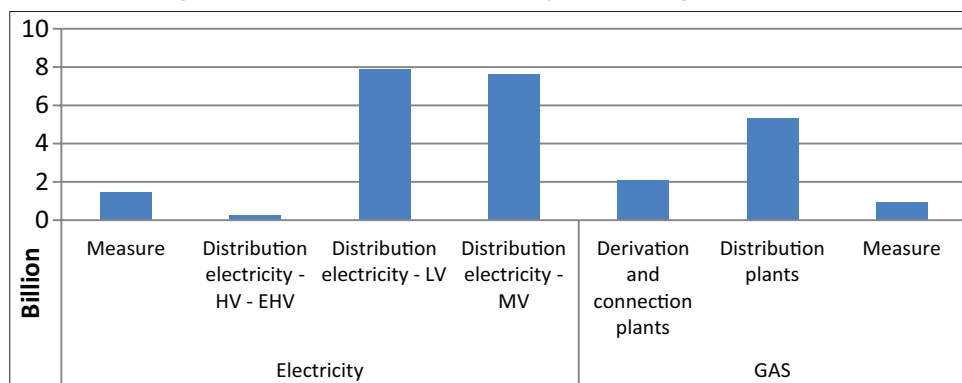
Aimed at verifying the hypothesis stating that investments in distribution plants are influenced by the company's form of ownership, the following econometric model was used:

$$Y_{\text{investments}} = \alpha + \beta_1 \times \text{PUBL} + \beta_2 \times \text{PRIV} + \beta_3 \times \text{company size}$$

This regression model includes the following variables:

- Two independent variables regarding the company's ownership structure.
 - PUBL: Fully public form of ownership. This a dummy variable that takes the value 1 in the case of enterprises fully owned by the state; otherwise, it takes the value 0
 - PRIV: Fully private form of ownership. This a dummy variable that takes the value 1 if private stakeholders own 100% of the shares; otherwise, it takes the value 0.

Figure n. 1: Investments in the electricity and natural gas distribution sectors.



Mixed public-private companies have been included in the analysis in the same way; they take the value “0” in both the variables described above.

2. Based on main literature (Dewenter and Malatesta, 2001; Megginson and Netter, 2001; Vining and Boardman, 1992), company size variables have been identified as control variables. More specifically, the variables taken into consideration are:

- Number of redelivery (gas) or withdrawal points (electricity)
- Volume distributed of gas (million m³/year) or electricity (GWh/year)
- Length of network (km).

When implementing multiple regression, it is important to check that the selected variables have a low level of collinearity

Table 3: Summary description of independent variables considered in the three models

Independent variables	Description
Company's ownership	
PUBL	A dummy variable that takes the value 1 in the case of wholly public-owned company
PRIV	A dummy variable that takes the value 1 in the case of wholly private-owned company
Company's size	
Model 1	Number of redelivery/withdrawal points
Model 2	Distributed volume in M (m ³) for gas and in GWh for electricity
Model 3	Network length in km

(measured via the variance inflation factor [VIF]). Since the VIF showed that there is a strong collinearity between the three variables regarding company size, it was necessary to implement three models, taking into consideration in turn one of the variables regarding size (control variable). The independent variables and the three models created by the variables of company size are summarized in Table 3.

6. RESULTS

Table 4 shows the descriptive statistics for gas and electricity distribution sector. The variation range in data for each variables seems to be large enough to capture properly their influence on the investments in distribution infrastructures. The investments in the electricity distribution infrastructure are on average much higher than those of the gas distribution, this is due to a much more developed network (the electricity network on average has a length of about 15 times longer than that of gas).

The results of the regression for electricity and gas distribution sectors, carried out by the method of ordinary least squares, are shown in Table 5.

For both sectors, the R² adjusted values are very high; therefore, the model is appropriate for the analysis. Moreover, the average value of VIF is <2 both sectors, showing a low collinearity between variables.

The variables referring to the size of infrastructure was significantly and positively associated with the amount of

Table 4: Descriptive statistics of the variables used in the empirical analysis

Variable	Min.		Max.		Mean		SD	
	Gas	Electricity	Gas	Electricity	Gas	Electricity	Gas	Electricity
Investments (M€)	9.035	130.942	2.456.950.869	12.413.270.384	176.373.570	613.558.051	560.272.562	2.472.821.306
Public ownership	0	0	1	1	0.44	0.24	0.51	0.44
Private ownership	0	0	1	1	0.27	0.32	0.46	0.47
Model 1 (n.)	5.160	440	3.807.433	31.556.656	329.813	1.422.065	898.544	6.289.707
Model 2 M(m ³) or GWh	3	2	7.372	224.901	675	10.259	1.756	45.774
Model 3 (km)	62	16	9.035	1.145.352	3.518	53.990	11.501	243.781

Table 5: Ordinary least square estimations for electricity and gas distribution

Gas distribution variables	Model 1		Model 2		Model 3	
	Estimates	SE	Estimates	SE	Estimates	SE
Number of redelivery points	0.954***	(0.001)				
Distributed volume			0.937***	(0.001)		
Network length					0.992***	(0.001)
Public ownership	-0.084**	(0.021)	-0.102**	(0.033)	-0.018**	(0.015)
Private ownership	-0.068**	(0.049)	-0.087**	(0.058)	-0.018**	(0.013)
VIF (average)	1.784		1.91		1.311	
Adjust R ²	0.991		0.985		0.999	
Electricity distribution variables						
Number of withdrawal points	0.992***	(0.001)				
Distributed volume			0.996***	(0.001)		
Network length					0.996***	(0.001)
Public ownership	-0.021**	(0.044)				
Private ownership	-0.025**	(0.021)				
VIF (average)	1.178		1.202		1.274	
Adjust R ²	0.998		0.999		0.999	

Significantly different from zero at the 99% (***), 95% (**), and 90% (*) confidence level. VIF: Variance inflation factor

investments (in both sectors). As for the form of ownership is concerned, by analysing the standardised values of β coefficients it was possible to establish which companies invest more in distribution infrastructures. In both sectors, taking into consideration that the coefficients of variables regarding public and private ownership are negative, it has been shown that mixed ownership companies are the enterprises investing the largest amount of resources. Indeed, because the dummy variable of mixed companies is achieved with $X_{\text{PRIV}} = X_{\text{PUB}} = 0$, the amount of investments made by these companies is larger than the amount of investments by state-owned and private companies, whose coefficient is negative. Therefore, it should be underlined that there is a negative relationship between fully public or fully private ownership and the amount of investments.

7. DISCUSSION AND IMPLICATIONS

According to the results of this study, there are significant differences between different forms of company ownership. Indeed, when enterprises are fully owned by either the state or private stakeholders, the company's form of ownership is not a driver for investments: The company's propensity to invest is only determined by size factors. Vice versa, mixed form of ownership positively influences the amount of investments.

These results clearly show that the main goal of enterprises fully owned by either the state or private stakeholders is not improving infrastructural investments both in quantitative and qualitative terms. Routine network maintenance absorbs most of the investments, whose amount depends on the network's size. On the contrary, when distribution companies are managed jointly by private and public stakeholders, there is greater propensity to invest into infrastructures, due to greater financing capacity. Indeed, mixed ownership companies receive better treatment from banks and may use corporate financing strategies, as opposed to enterprises fully owned by the state, which may find it more difficult to find the necessary financial resources. On the other hand, on average, companies fully owned by private stakeholders are characterised by better financial stability; however, they may not be eager to increase investments because this would translate into a decrease in profits, at least during the period of investment amortisation.

These results also imply that policy makers should encourage mixed ownership, because these forms of ownership are the best in terms of infrastructural investments, thus making it possible to achieve both social goals and technological efficiency.

These results are in line with the main literature analysing mixed companies in general, thus underlining how this form of ownership allows to improve both performance and efficiency (Bel and Fageda, 2010; Bognetti and Robotti, 2007; Monteduro, 2014; Schmitz, 2001). Mixed ownership companies usually deliver better performances because the advantages of mixed management (including better know-how, more independence in management decisions, increased focus on economic performance monitoring, etc.) outnumber its disadvantages

(such as complexity of governance, conflicts between public and private stakeholders, etc.) (Monteduro, 2014). Finally, Bel and Fageda (2010) have shown that mixed companies seem to be the best solution, offering the opportunity to benefit from "the best of both worlds": Indeed, while high transaction costs and lack of industrial interests may dissuade from choosing fully private ownership, financial constraints may discourage from resorting to fully public ownership.

8. CONCLUSIONS

This study is aimed at assessing how the form of ownership of energy distribution utilities affects investments. This paper revolves around the challenges currently tackled by the natural gas and electricity sectors, where infrastructure investments play a vital role in both increasing the companies' internal efficiency and developing national economic systems.

Decisions on investments and innovation in the energy distribution sector are at the very core of a transition process which should make energy networks smarter and more flexible, in order to improve their efficiency, safety, and reliability.

A multiple regression model was used to verify whether the form of company ownership influences the companies' propensity to invest, taking into consideration control variables concerning company size, which otherwise may have caused a bias in the study's results.

The study sample includes 59 energy companies (34 in the natural gas sector and 25 in the electric energy sector), accounting respectively for 63% and 98.5% of the total energy distribution market.

The results of this study show that there is a statistically significant relationship between the companies' propensity to invest and their form of ownership. In particular, there is a positive relationship between mixed public-private ownership and the company's propensity to invest into infrastructural networks. This conclusion seems to be confirmed by the growth trend of mixed public-private ownership companies in the last decade: Indeed, these companies are playing an increasingly central role in several European countries (Bel and Fageda, 2010).

The findings of this paper suggest that policy makers should encourage mixed forms of ownership, including PPP, because mixed companies are more inclined to invest into infrastructure, thus contributing to improving the wellbeing of society at large. Indeed, mixed companies are potentially able to mitigate the trade-off between the financial constraints that often affect state owned enterprises and the private stakeholders' focus on generating - and maximising - profit, which often leads them to focus on reducing costs rather than improving quality. Therefore, involving private partners in the ownership of state-owned enterprises allows to implement both innovation projects aimed at reducing costs and those aimed at improving service quality (Monteduro, 2014).

In future, research may be extended to encompass other energy and utilities sectors, such as water and waste, which were omitted from this study due to lack of data. In general, also when these sectors are concerned, the main literature shows that mixed ownership allows to combine universality and social goals (among the priorities of state-owned enterprises) with efficiency and economic performance goals (which are key objectives of most private companies). Therefore, it may be interesting to assess the impact of these companies' form of ownership on their propensity to invest, in order to establish whether the conclusions drawn for the gas and electricity industries may be extended to other sectors characterised by the presence of infrastructural networks.

REFERENCES

- Alchian, A.A., Demsetz, H. (1972), Production, information costs, and economic organization. *The American Economic Review*, 62(5), 777-795.
- Andrews, W.A., Dowling, M.J. (1998), Explaining performance changes in newly privatized firms. *Journal of Management Studies*, 35(5), 601-617.
- ARERA. (2008), Delibera n. 155. Direttive per la Messa in Servizio dei Gruppi di Misura del gas, Caratterizzati da Requisiti Funzionali Minimi e con Funzioni di Telelettura e Telegestione, per i Punti di Riconsegna delle reti di Distribuzione del gas Naturale. Available from: <http://www.arera.it>.
- ARERA. (2017), Relazione Annuale Sullo Stato dei Servizi e Sull'Attività Svolta. Available from: <http://www.arera.it>.
- Barberis, N., Boycko, M., Shleifer, A., Tsukanova, N. (1996), How does privatization work? Evidence from the Russian shops. *Journal of Political Economy*, 104(4), 764-790.
- Bel, G., Fageda, X. (2009), Factors explaining local privatization: A meta-regression analysis. *Public Choice*, 139(1-2), 105-119.
- Bel, G., Fageda, X. (2010), Partial privatisation in local services delivery: An empirical analysis of the choice of mixed firms. *Local Government Studies*, 36(1), 129-149.
- Bognetti, G., Robotti, L. (2007), The provision of local public services through mixed enterprises: The Italian case. *Annals of Public and Cooperative Economics*, 78(3), 415-437.
- Bolton, R., Foxon, T.J. (2015), Infrastructure transformation as a socio-technical process Implications for the governance of energy distribution networks in the UK. *Technological Forecasting and Social Change*, 90, 538-550.
- Bortolotti, B., Fantini, M., Siniscalco, D. (2004), Privatisation around the world: Evidence from panel data. *Journal of Public Economics*, 88(1-2), 305-332.
- Boycko, M., Shleifer, A., Vishny, R.W. (1996), A theory of privatisation. *The Economic Journal*, 106(435), 309-319.
- Capece, G., Cricelli, L., Di Pillo, F., Levialdi, N. (2009), The Italian Gas Retail Market: A Cluster Analysis Based on Performance Indexes. Vol. 121. WIT Transactions on Ecology and the Environment.
- Capece, G., Di Pillo, F., Levialdi, N. (2013), Measuring and comparing the performances of energy retail companies. *International Journal of Energy Sector Management*, 7(4), 491-515.
- Demsetz, H. (1988), Ownership, Control, and the Firm: The Organization of Economic Activity. Vol. 1. Cambridge, Oxford: Blackwell.
- Dewenter, K.L., Malatesta, P.H. (2001), State-owned and privately owned firms: An empirical analysis of profitability, leverage, and labor intensity. *American Economic Review*, 91(1), 320-334.
- Ehrlich, I., Gallais-Hamonno, G., Liu, Z., Lutter, R. (1994), Productivity growth and firm ownership: An analytical and empirical investigation. *Journal of Political Economy*, 102(5), 1006-1038.
- Estrin, S., Hanousek, J., Kocenda, E., Svejnar, J. (2009), The effects of privatization and ownership in transition economies. *Journal of Economic Literature*, 47(3), 699-728.
- Garrone, P., Grilli, L., Rousseau, X. (2011), Utility municipali: Influenza politica o discrezionalità del management? *L'INDUSTRIA*, 32(1), 69-91.
- Grossman, S.J., Hart, O.D. (1986), The costs and benefits of ownership: A theory of vertical and lateral integration. *Journal of Political Economy*, 94(4), 691-719.
- Grout, P.A., Stevens, M. (2003), The assessment: financing and managing public services. *Oxford Review of Economic Policy*, 19(2), 215-234.
- Hart, O., Moore, J. (1999), Foundations of incomplete contracts. *The Review of Economic Studies*, 66(1), 115-138.
- Laffont, J.J., Tirole, J. (1991), Privatization and incentives. *Journal of Law, Economics, and Organization*, 7, 84.
- Loorbach, D., Frantzeskaki, N., Thissen, W. (2010), Introduction to the special section: Infrastructures and transitions. *Technological Forecasting and Social Change*, 77(8), 1195-1202.
- Matsumura, T., Kanda, O. (2005), Mixed oligopoly at free entry markets. *Journal of Economics*, 84(1), 27-48.
- Meggison, W.L., Netter, J.M. (2001), From state to market: A survey of empirical studies on privatization. *Journal of Economic Literature*, 39(2), 321-389.
- Mekhdiev, E.T., Prokhorova, V.V., Makar, S.V., Salikhov, G.G., Bondarenko, A.V. (2018), Smart cities in future energy system architecture. *International Journal of Energy Economics and Policy*, 8(5), 1-8.
- Menozzi, A., Vannoni, D. (2011), Corporate governance and performance in local public utilities. *L'industria*, 32(1), 93-112.
- Ministry of Economic Development. (1999), Decreto Legislativo 16 marzo 1999, No. 79, Attuazione Della Direttiva 96/92/CE Recante Norme Comuni per il Mercato Interno Dell'energia Elettrica. Available from: <http://www.gazzettaufficiale.it>.
- Ministry of Economic Development. (2000), Decreto Legislativo 23 Maggio 2000, No. 164, Attuazione Della Direttiva n. 98/30/CE Recante Norme Comuni per il Mercato Interno del Gas Naturale. Available from: <http://www.gazzettaufficiale.it>.
- Moe, R.C. (1987), Exploring the limits of privatization. *Public Administration Review*, 47(6), 453-460.
- Monteduro, F. (2014), Public private versus public ownership and economic performance: Evidence from Italian local utilities. *Journal of Management and Governance*, 18(1), 29-49.
- Peters, J. (2012), Neoliberal convergence in North America and Western Europe: Fiscal austerity, privatization, and public sector reform. *Review of International Political Economy*, 19(2), 208-235.
- Price, B.E. (2007), The threat of privatization: The impetus behind government performance. *International Journal of Public Administration*, 30(11), 1141-1155.
- Rossi, M., Festa, G., Gunardi, A. (2019), The evolution of public-private partnerships in a comparison between Europe and Italy: Some perspectives for the energy sector. *International Journal of Energy Economics and Policy*, 9(3), 403.
- Schmitz, P.W. (2001), Partial privatization and incomplete contracts: The proper scope of government reconsidered. *FinanzArchiv: Public Finance Analysis*, 57(4), 394-411.
- Shleifer, A. (1998), State versus private ownership. *Journal of Economic Perspectives*, 12(4), 133-150.
- Somma, E., Rubino, A. (2016), Public-private participation in energy infrastructure in Middle East and North African countries: The role of institutions for renewable energy sources diffusion. *International Journal of Energy Economics and Policy*, 6(3), 621-629.

- Villalonga, B. (2000), Privatization and efficiency: Differentiating ownership effects from political, organizational, and dynamic effects. *Journal of Economic Behavior and Organization*, 42(1), 43-74.
- Vining, A.R., Boardman, A.E. (1992), Ownership versus competition: Efficiency in public enterprise. *Public Choice*, 73(2), 205-239.
- Wang, K.T., Shailer, G. (2018), Does ownership identity matter? A meta-analysis of research on firm financial performance in relation to government versus private ownership. *Abacus*, 54(1), 1-35.
- Yarrow, G. (1986), Privatization in theory and practice. *Economic Policy*, 1(2), 323-364.