One more ride on the merry-go-round! Public ownership and delayed competition in local public services

Riccardo Marzano [a,b,*]

[a] *University of L'Aquila, Department of Industrial and Information Engineering and Economics, Via Gronchi 18, 67100 L'Aquila, Italy*
[b] *Polytechnic University of Milan, Department of Management, Economics and Industrial Engineering, Via Lambruschini 4/b, 20156 Milan, Italy*

Received 6 August 2014
Revised 6 March 2015

1. Introduction

Since the launch of network industries liberalization programs around the world, concerns have been raised about the real scope of regulatory independence. In fact, the timing of privatization and liberalization has varied from country to country and sector to sector, generating situations in which the state, at different levels of government, has acquired the role of regulator without losing its traditional role of owner (Bortolotti and Faccio, 2009; Bortolotti et al., 2003; Conway and Nicoletti, 2006).

"How can the state regulate the firms it also runs?" (*The Economist*, 22 January, 2012). This question is crucial for several reasons. First, the commitment of governments to abstain from influencing regulatory outcomes has an impact on investor decisions to enter markets, which in turn affects both static and dynamic efficiency (Cambini and Rondi, 2011; Henisz, 2000; Henisz and Zelner, 2001). Second, it strikes at the heart of the dilemma regarding the legitimacy of public ownership in markets in which private investors expect to compete in a transparent regulatory framework. Third, if a case for public ownership still exists, addressing this question will be the first step toward the creation of the institutional arrangements that prevent the blurring of roles of regulator and owner (Baldwin and Cave, 1999; Levy and Spiller, 1994).

* Corresponding author.
E-mail address: riccardo.marzano@polimi.it

In this paper, I document the effect of municipal ownership on a regulatory outcome, i.e. the use of competitive bidding to award local monopoly franchises, by relying on the Italian natural gas liberalization reform as an empirical setting. The reform was issued in 2000 and introduced dramatic changes within the entire natural gas industry. In particular, it revolutionized the distribution segment, which is dominated by municipally owned enterprises (MOEs); in 1998, they represented 454 out of 734 enterprises. The reform established that gas distribution franchises should be awarded by competitive bidding at the municipality level (Armstrong and Sappington, 2006; Demsetz, 1968; Riordan and Sappington, 1987). Specifically, I compare the timing of the decision to comply with the reform as it was experienced by the population of Lombard municipalities, which are followed from 2001 to 2012 (the extreme deadline established by the reform). The results indicate that a municipality owning a capital share in the incumbent gas distribution network operator (DNO) experiences a significant reduction in the probability of complying with the reform (as measured at each year interval).

Recent studies have found significant links between public ownership and regulatory outcomes. Edwards and Waverman (2006), using a sample of 15 incumbent EU telecom operators tracked from 1997 to 2003, show that public ownership positively affects wholesale rates, suggesting that governments influence regulatory outcomes to favor publicly owned incumbents. Bortolotti et al. (2011), using a panel of EU utilities, analyze how firm ownership and regulatory independence affect capital structure and regulated prices.[1] Bortolotti et al. (2013), using the same panel employed in the previous work, focus on the impact of public ownership on the market value of regulated firms. All of these analyses have concluded that a case for regulatory failure exists in the contexts in which strong publicly controlled incumbents dominate network industries.

However, the literature thus far has paid no attention to the challenges offered by the dispersion of public ownership and regulatory powers along different levels of government – national, regional and municipal. MOEs play a key role in the provision of public services – the majority of them encompassing network industries such as electricity, gas, water, waste and transport – across the EU countries.[2] At the same time, even in countries and sectors where a national Independent Regulatory Agency (IRA) exists, local governments – depending on the institutional framework shaping each sector in each country – maintain residual regulatory powers, ranging from monopoly franchising to planning and control of management activity, budget and investment decisions, quality standards and so forth.

When residual regulatory powers are entrusted to local institutions, they are nearly inseparable from the executive power. Municipalities do not delegate market regulation to independent agencies, as central governments do. Accordingly, local political power can condition regulatory decisions and undermine the credibility of the regulatory commitment (Guerriero, 2011; Hauge et al., 2012). In these situations, local politicians may use their executive powers to make regulatory decisions that boost MOEs profitability and/or protect them from potential competitors (Sappington and Sidak, 2003). This in turn allows local governments to raise additional revenues and hence to avoid municipal tax increases, spending cuts or other politically costly choices.

This study makes two contributions to the literature. First, by focusing on the enforcement of a well-defined regulatory tool, the analysis allows to establish a direct channel between the public ownership of firms and regulatory outcome. Unlike the abovementioned studies, the present paper exploits a liberalization reform for the purpose of measuring and explaining regulatory outcome as such, i.e., not relying on indirect proxies such as prices, market values and so on.

Second, by employing a sample of municipalities that share the role of market regulator (provided that they wield the regulatory power to decide when to award the gas distribution franchise) and are heterogeneous in terms of the economic stake in the gas distribution market (provided that only a few of them are *shareholders* of incumbent DNOs), this paper is the first, to the best of my knowledge, to focus on the relationship between public ownership and regulatory enforcement at the local level. This allows the possibility to exploit a larger sample and to circumvent the heterogeneity of contexts and institutional arrangements that challenges studies focusing on the national level.

The approach presents two empirical advantages. First, it is possible to study how the change in the regulatory framework has been recognized by municipalities that potentially face the same obligations. This makes it possible to avoid empirical challenges stemming from the simultaneity of regulatory reform and public ownership. Second, by using a duration model, it is possible to take into account not only the resistance to the reform by the municipalities that are not compliant at all but also the resistance exerted by those that delay compliance.

The paper provides additional tests to support the causal interpretation of the findings.
First, I seek to overcome the inference challenges stemming from the endogeneity of (i) municipal ownership and (ii) variations in the deadlines for compliance due to the staggered implementation of the reform. While the first source of endogeneity should be quite clear – as each municipality should decide whether to have a competitive bidding process or not, and it also needs to decide if it wants to have shares in the incumbent DNO – the second one is contingent upon the way in which the transition period for the implementation of the reform has been provided for. In fact, the gas distribution reform established a staggered implementation, by allowing the municipalities served by DNOs that met certain requirements – in terms of size and privately owned capital shares – to delay the deadline for compliance. Given the chance to enjoy an extended transition period, the possibility that the most resistant *shareholder* municipalities may have implemented restructuring measures to ensure that their

[1] They find that privately controlled firms are more highly leveraged than state-controlled firms if they are regulated by an Independent Regulatory Agency (IRA) and that the leverage of private firms has a positive and significant effect on regulated prices. While these results are consistent with the theory that private regulated firms use leverage strategically to obtain better regulatory outcomes (Spiegel and Spulber, 1994), they also suggest that state-controlled companies do not have to rely on such a strategic device.

[2] In addition to Italy, as far as the European Union is concerned, local public services (LPS) are mainly provided by municipally owned enterprises in Austria, Germany, Greece, Portugal, Spain, Ireland, Sweden and in the majority of the countries in Eastern Europe (Verdier, 2004).

municipally owned DNOs meet the time *extension* requirements cannot be ruled out. To address these empirical challenges, I jointly estimate the model of competitive bidding compliance with the probability of being a *shareholder* of the incumbent DNO and the determination of the *extension* of the transition period.

Second, I test the credibility of competitive procedures by estimating a model of incumbency. When local governments are indeed both owners of the incumbent and designers of the competitive procedures, the possibility that the threat of losing franchises is not highly credible cannot be ruled out.

Third, I take into account the presence of a contemporaneous dependence structure in the data. For each municipality, the decision to award the gas distribution franchise can depend on the decisions made by other municipalities served by the same DNO. If this "imitation effect" is indeed in place, not controlling for it may produce biased estimates.

The rest of the paper is organized as follows. Section 2 provides the theoretical framework. Section 3 summarizes the institutional setting by describing the Italian reform of the gas distribution sector. Section 4 presents the data and summary statistics. Section 5 defines the empirical strategy and the additional tests performed to validate the causal interpretations of the findings. Section 6 reports the main results, and Section 7 presents the results of the incumbency and spatial models. Section 8 concludes and discusses the implications of the findings.

2. Theoretical framework

Suppose we have a policy maker who can be thought of as the legislative branch of the national government and who maximizes society's welfare. He chooses competitive bidding as a regulatory tool to maximize efficiency in the gas distribution market (Demsetz, 1968; Riordan and Sappington, 1987). Moreover, he puts local governments in charge of implementing this regulatory policy.

The local government is simultaneously responsible for two issues: public spending and implementation of the regulatory policy (as in Besley and Coate, 2003). Each local government has to decide if to comply with the policy and accordingly organize a competitive bidding procedure to award the gas distribution franchise in the municipality he runs as soon as possible ($CP = today$), or to delay the policy compliance ($CP = tomorrow$).

The DNOs have private information about their marginal costs and are regulated by a national IRA, which is in charge of setting the unit price for the gas distribution service p, and a transfer payment T, from consumers to the DNOs. Each DNO can be efficient (when it exhibits low marginal cost of production c_L) with probability ϕ or inefficient (when it exhibits high marginal cost of production c_H) with probability $(1-\varphi)$. Moreover, it is common knowledge that each DNO incurs fixed cost $F \geq 0$ in order to operate.

The IRA implements unit price p_j and transfer payment T_{ij} when the DNO serves municipality i and claims to have marginal cost c_j, for $j = L, H$. Accordingly, the DNO's rent will be $R_{ij} = Q_i(p_j)(p_j - c_j)\text{-}F + T_{ij}$, where Q_i is the demand for the gas distribution service in the municipality i. Following Armstrong and Sappington (2007), in order to assure that both participation and incentive constraints are fulfilled and a second-best solution is implemented, the IRA must set $p_L = c_L$, $p_H > c_H$ and transfer payments to make sure that $R_{iH} = 0$ and $R_{iL} = (c_H - c_L)Q_i(p_H)$ are the rents accruing to DNO that serves municipality i and claims to have marginal cost c_H and c_L respectively.[3] Thus, only efficient DNOs enjoy an informational rent, which is assumed to be municipality-specific and socially costly. Such an informational rent can be partially extracted by using the competitive bidding procedure. Again, following Armstrong and Sappington (2007), who developed a setting based on the Baron and Myerson (1982) model to illustrate how franchise bidding may be employed to discipline a monopoly supplier, the rent-reducing benefit of competitive procedures allows the efficient DNO rent to become $R_{iLCP} = \frac{\rho_H}{\rho_L} R_{iL} < R_{iL}$, where ρ_H and ρ_L are the high cost DNO and low cost DNO's perceived probabilities of winning the competitive procedure respectively (with $\rho_L > \rho_H$).

In case of delayed implementation, the local government incurs the cost of noncompliance nc.[4] The municipality i may be a *shareholder* ($i \in Sh$) or non-*shareholder* ($i \in Nosh$) of the incumbent DNO. I assume that when the municipality is not a *shareholder*, the local government does not observe any informative signal for the DNO's costs.[5] On the contrary, when the municipality is a *shareholder*, the local government can fill the informational gap on the DNO's costs without incurring any costs. This is the same as assuming that the local politician, who is in charge of running the local government, and the public manager, who is in charge of running the municipally owned DNO, are perfectly exchangeable.[6]

The local government can be assumed to be benevolent or not. If he is benevolent, he is supposed to behave in the public interest. Accordingly, regardless of whether the municipality is a *shareholder*, the local government is expected to comply with the reform as soon as possible, i.e., *today*. In fact, prompt compliance is due to the desire to avoid the cost of noncompliance, and accordingly minimize public spending, and to extract part of the informational rent as soon as possible.

[3] The optimal regulatory policy is the one that induces each DNO to employ its cost information to reach a second-best outcome that approximate the full information outcome (the first-best). Suppose the DNO with marginal cost c_L and serving municipality i chooses the (p_L, T_{iL}) option. Its rent will be $Ri_L = Qi(p_L)(p_L - c_L)\text{-}F + Ti_L$. In contrast, if this DNO chooses the alternative (p_H, T_{iH}) option, its rent will be $Qi(p_H)(p_H\text{-}c_L)$ - $F + Ti_H = Ri_H + Qi(p_H)(c_H\text{-}c_L)$. It follows that if the efficient DNO is to be induced to choose the (p_L, T_{iL}) option, it must be the case that $Ri_H = 0$ and $Ri_L = Qi(p_h)(c_H - c_L)$.

[4] Cost of noncompliance may consist of the cost of appealing to the administrative court or antitrust judgments to postpone the competitive procedure.

[5] This is consistent with the lack of a monitoring technology that would make it possible for local governments to learn hard information about the DNO's costs (as in Martimort, 1999). As previously mentioned in Section 1, local governments do not delegate regulation to regulatory agencies, and this makes it difficult (if not impossible) filling the informational gap on firm costs.

[6] Although this assumption may be considered too strong, it should be recalled that most of the sample includes municipalities with less than 10,000 inhabitants. This makes the connections between local politicians and public managers very thick, and information flows very dense.

Let us switch to the case in which the local government is not benevolent. If he is not benevolent, he is supposed to be self-interested. In this setting, both the local government and the DNO have incentives to use information to promote their private interests. The private interest of local government is shaped by political considerations (Dinç, 2005; Dinc and Gupta, 2011; Shleifer and Vishny, 1994). Local politicians are indeed eager to promote their consent by using any rent to avoid spending cuts and tax increases or to allow excess employment – both in the departments of the local administration and in the DNO they eventually own (Cox and McCubbins, 1986).

Let us consider the case in which the municipality is not a *shareholder*. The local government has no hard information about the DNO's costs, but he can use his discretionary power to appropriate part of the rent. In particular, the local government can make the DNO a take-it-or-leave-it offer that entails delayed implementation in exchange for the transfer of the expected differential rent enjoyable by the DNO. The expected differential rent is as follows: $R_{iL} - \rho_L R_{iLCP} = R_{iL} - \rho_H R_{iL} = (1 - \rho_H)R_{iL}$, where R_{iL} is the efficient DNO's rent in case of delayed implementation and $\rho_L R_{iLCP}$ is the expected rent accruing to the efficient DNO in case of prompt compliance.

The local government who runs municipality i will make the take-it-or-leave-it offer as long as follows:

$$(1 - \rho_H)R_{iL} > nc + s \tag{1}$$

where the left-hand side of the inequality is the expected differential rent at stake, nc is the abovementioned cost of noncompliance and s is the cost of bargaining with the DNO incurred by the local government.[7] The offer will be accepted only by an efficient DNO, i.e., only with probability ϕ. Thus, the probability of delayed compliance in a non-*shareholder* municipality turns out to be

$$\Pr_i[CP = tomorrow \mid i \in Nosh] = \phi \Pr[(1 - \rho_H)R_{iL} > nc + s] \tag{2}$$

Alternatively, in the case in which the municipality is a *shareholder*, because of the perfect information sharing between politicians and public managers, the local government, when the municipally owned DNO is an efficient one, can freely dispose of the entire information rent. As before, delayed compliance would entail an expected differential rent equal to $(1 - \rho_H)R_{iL}$. The local government will seek to keep it by postponing as much as possible the competitive bidding procedure, even to the point of suffering noncompliance costs. On the contrary, the local government has no incentive to delay the competitive procedure when the municipally owned DNO is inefficient, because in any case there is no differential rent to extract. In this setting, cost of bargaining is zero, because of the perfect exchangeability between local politicians and public managers. Thus, the probability of delayed compliance in a *shareholder* municipality turns out to be

$$\Pr_i[CP = tomorrow \mid i \in Sh] = \phi \Pr[(1 - \rho_H)R_{iL} > nc] \tag{3}$$

The presence of the cost of bargaining makes it possible to conclude that

$$\Pr_i(CP = tomorrow | i \in Sh) - \Pr_i(CP = tomorrow | i \in Nosh) > 0 \tag{4}$$

Inequality (4) shows that the probability of delayed compliance in *shareholder* municipalities is higher than in non-*shareholder* ones. This result will be tested in the empirical part of the paper by using a duration model which compares the hazard rate of compliance for the two groups of municipalities.

3. Institutional setting

The structure of the natural gas industry includes four upstream phases, i.e., production, wholesale trade (including imports and exports), storage and transmission, and two downstream phases, i.e., distribution and retail.

In the past, the Italian natural gas industry was dominated by ENI, the vertically integrated state-owned enterprise that exercises most of the exclusive rights in exploration, production, international trade and storage. The ENI subsidiary SNAM operated the national gas transmission pipelines and enjoyed a monopoly on the supply to the wholesale market. Distribution and retail were bundled activities carried out either by MOEs or by private firms on the basis of local concessions granted by each municipality. State regulation monitored the price at which local distribution and retail companies could sell natural gas to their customers.

In 2000, the Italian Parliament issued a law that implemented the 1998 EU Directive on the European natural gas industry for the purpose of introducing competition in the national natural gas market (Law Decree no. 164 of 2000). A threshold was imposed on the quota of natural gas imported by a single firm; gas transmission and distribution were unbundled from gas supply and retail. In this way, the transmission and distribution network operations – the natural monopoly segments of the industry – were separated from the potentially competitive segments, which were opened to new entrants; third-party access to infrastructure was established to allow competition for the provision of natural gas services on similar commercial grounds; natural gas prices were determined to be no longer regulated but dependent on the interactions of supply and demand; the AEEGSI (former AEEG) was established as the national natural gas IRA.

[7] The bargaining cost can be related not only to the cost required to come to an agreement with the DNO, but also the political cost of being unmasked incurred by the local government or the enforcement cost, i.e., the cost of making sure the DNO sticks to the terms of the implicit contract.

As far as the distribution sector is concerned, a two stage regulatory framework was introduced. Tariffs and the service quality were determined to be regulated at the national level and were accordingly entrusted to the AEEGSI. Conversely, planning and control functions were committed to local governments (Garrone and Marzano, 2014).

The main innovation introduced by the reform was the compulsory competitive bidding procedures to select the natural gas DNO at the municipality level. Local governments were established as franchising authorities. The franchise duration was set to 12 years, at the end of which the infrastructures were required to return to the municipalities.

The reform ordained that franchises should be awarded following the "most economically advantageous tender" approach, i.e., on the basis of the best economic conditions in terms of the non-regulated prices (mainly prices charged for establishing new gas connections), safety levels, programs for investment in the network and plants, technology levels, and so on. At the end of the competitive procedure, a service contract is signed between the local authority and the winning bidder, with clauses based on the winning bid.

The reform allowed a five-year transition period. Therefore, the deadline for organizing competitive bidding procedures was initially set for the end of 2005. Moreover, combining time *extensions* were granted to the municipalities served by DNOs under the following conditions: (a) a one-year *extension* for a DNO that is the outcome of a merger occurring within the 2000–2005 period and doubling the number of customers; (b) a two-year *extension* when the number of customers served is at least 100 thousand, or the supplied gas is at least 100 million mc per year, or the natural gas DNO operates in a territory corresponding to a province; and (c) a two-year *extension* when the private shareholdings of the natural gas DNO account for at least 40% of shares. The transition period was later postponed by two years, leading all earlier franchises to expire at the latest by the end of 2012, i.e., when all of the time-*extension* requirements were met.

4. Data

Lombardy has 9.704 million inhabitants, a sixth of Italy's population, and comprises 1544 municipalities, distributed among 12 provinces. Approximately one-fifth of Italy's GDP is produced in the region. Lombardy has been chosen as the case study because it is the largest regional natural gas market in Italy. In 2012, 4.8 million residential customers were supplied with 8992 million mc of natural gas (i.e., roughly one-fourth of the national supply) through distribution networks that cover a distance of 47,033 km and reach nearly all of the municipalities.[8,9]

The sample consists of all Lombard municipalities in which a natural gas distribution network is operational. Municipalities are followed from 2001 to the year in which they organize a competitive procedure to award the gas distribution service franchise, if they in fact do so. Otherwise, they are right censored at the end of 2012. At the beginning of the follow up period, they are 1408 (overall population of 9.017 million). From 2002 to 2005, nine municipalities were connected to the regional system of natural gas infrastructures for the first time, bringing the total number of observed municipalities to 1417. The remaining municipalities are connected to LPG (liquefied petroleum gas) networks or do not provide gas distribution service. Table 1 displays the number of observed municipalities over time.

In sum, 378 out of 1417 municipalities have made the decision to comply with the reform and organize a competitive procedure. Some municipalities have appealed to administrative courts or the antitrust courts requesting a suspension of the obligation. Others have simply played for time, exploiting the instability of the normative framework.[10] In short, municipalities have resisted the reform. The 2010–2011 time period is the one in which the majority of the competitive procedures were organized in Lombardy. Not a single one was organized in 2001 and in 2012.[11]

To retrieve the decisions made by the Lombard municipalities regarding when organizing a competitive procedure, two sources have been combined. The first is the online version of the supplement of the *Official Journal of the European Union* (the so-called "Tenders Electronic Daily"), which collects all calls for tenders issued by EU local, regional and national authorities to award service and public procurement contracts. The second comprises the annual reports of natural gas DNOs operating in Lombardy from 2001 onward, which give information about the franchises yearly lost, gained or regained through competitive bidding.

In 2001, approximately 18% of the sampled municipalities are *shareholders* of a natural gas DNO. The figure decreases to 15% in 2012, mainly due to the exit of non-corporatized DNOs following the competitive procedures organized by their served municipalities. Information about the presence of each municipality in the list of the *shareholders* of a natural gas DNO has been collected from the annual reports of DNOs classified as municipally owned.

[8] The data for this subsection have been sourced from the annual reports, publications and statistics that are published by the AEEGSI (http://www.autorita.energia.it/it/index.htm) and the Italian Association of Municipal Utilities (http://www.federutility.it/).

[9] It should be emphasized that the case has some elements of generalizability. In fact Lombardy, as a natural gas market, is comparable to entire European countries such as Austria, Belgium, and Poland. In 2012, aggregate gas consumption in Lombardy amounted to 16,869 cubic meters compared to 9416 in Austria, 18,244 in Belgium and 17,279 in Poland (Eurostat Data). Moreover, Lombardy is the Italian region with the most significant presence of owners of natural gas DNOs among the municipalities, and at the same time, it has displayed one of the highest rates of compliance with the reform (approximately 26% of Lombard municipalities organized a competitive procedure between the years 2001 and 2012). Thus, the choice of Lombardy to study resistance toward competitive bidding seems to be sufficiently conservative.

[10] The rules regulating the transition from direct awarding to the competitive bidding in the Italian gas distribution sector have been subjected to an intense normative activity since 2000. Only to give an idea the rules have been changed three times from 2004 to 2007.

[11] In 2012, the Italian gas distribution sector was reformed again. The Italian territory was divided into 177 areas (ATEM), and a new decree established the obligation to organize joint competitive procedures to award a franchise for each ATEM.

Table 1
Observed municipalities.

Panel A – Observed municipalities	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Followed municipalities in $t-1$	–	1408	1416	1403	1383	1371	1347	1336	1322	1305	1285	1165
Newly methanized	–	8	0	0	1	0	0	0	0	0	0	0
CP in $t-1$	–	0	13	20	13	24	11	14	17	20	120	126
Followed municipalities	1408	1416	1403	1383	1371	1347	1336	1322	1305	1285	1165	1039
Missing	3	4	22	14	1	0	0	1	1	4	1	55
Observed municipalities	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984
Panel B – Observed municipalities by population size	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
>100,000	4	4	4	4	4	4	4	4	4	4	4	3
50,000–100,000	10	10	10	10	10	9	9	10	10	10	9	6
30,000–50,000	23	23	23	23	23	23	24	23	24	24	21	16
10,000–30,000	126	126	120	123	125	126	124	123	122	125	112	88
5000–10,000	231	223	221	222	223	224	230	231	228	217	200	171
1000–5000	744	756	734	726	729	711	696	686	678	665	595	507
<1000	267	270	269	261	256	250	249	244	238	236	223	193
Observed municipalities	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984
Panel C – Municipal shareholders	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Shareholders	257	267	254	242	244	243	236	236	218	212	204	167
Non-*shareholders*	1148	1145	1127	1127	1126	1104	1100	1085	1086	1069	960	817
Observed municipalities	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984

Panel A reports the number of municipalities followed by year. As years pass, the number of municipalities increases with the addition of newly methanized cities and decreases with the exit of those that re-award the gas distribution service via competitive bidding. Missing observations are due to the unavailability of information along one or more variables employed in the econometric model. Panel B illustrates the distribution of observed municipalities by the range of population size. Panel C reports the number of *shareholders* of a DNO among the observed municipalities.

4.1. Data on natural gas DNOs

In 2001, the number of natural gas DNOs operating in Lombardy amounted to 216. The private operators numbered 73 and served 1049 municipalities, accounting for a population of 3.985 million. The municipally owned DNOs numbered 74 and served 286 municipalities, accounting for a population of 4.474 million. The residual 70 municipalities, accounting for a population of 0.559 million, were served by 69 ad hoc departments of the local administration (i.e., a non-corporatized DNO).[12] DNO characteristics are summarized in Table 2.

During the observation period, in only one case was the gas distribution service maintained by the departments of the local administration. In all of the other cases, competitive procedures resulted in the contracting out of the service to private or external municipally owned DNOs.

The data encompassing the characteristics of natural gas DNOs operating in Lombard municipalities over time have been obtained from the AEEGSI website, which provides a register of all natural gas DNOs by the served area. The ownership structures of DNOs have been scrutinized using their annual reports, while their size has been measured by the cumulative population of served municipalities. Retrieving information on DNOs' ownership structure and size has not been straightforward. First, a large number of mergers and acquisitions (M&A) have occurred during the follow-up period among DNOs in the sample. To this aim, tracking the evolution of DNOs' served area has been proved to be of benefit. As a matter of fact, M&A operations have the transfer of gas distribution franchises from the acquired DNO to the acquiring one as a natural consequence.[13,14] Second, in some cases DNOs have changed their name simply because of organizational changes in the corporate group structure.

After having categorized the natural gas DNOs in terms of ownership arrangements and size, it has been possible to infer the *extension* to the transition period for each DNO and thus indirectly for each served municipality. It ranges from 0 to 5 and is constructed by summing up the *extension* years relative to each of the three requirements established by the decree, if met by the DNO (see the last paragraph of Section 3). Therefore, *extension* is set equal to 1, if the municipality is served by a DNO that is the outcome of a merger having doubled the number of customers and does not meet requirements (b) and (c); it is set equal to

[12] DNOs in some cases can operate in regions other than Lombardy. This is the case for the largest DNOs.

[13] During the 2001–2012 period new operators have entered by taking over existing DNOs, mainly among private ones. Alternatively, they have entered by taking part in competitive procedures. Through the dataset it is possible to distinguish the two entering modes by using information on competitive procedures actually organized.

[14] In some cases, the sampled DNOs are companies belonging to corporate groups with activities in an array of local public services, such as electricity, water, waste, telecommunication, district-heating, … In this case, municipalities hold the DNO only indirectly. Moreover, several municipally-owned enterprises have merged only their gas distribution service branches. This means that the original MOEs still exist and new jointly owned companies have been established. When this happened the ownership links between each municipality and the DNO have become indirect.

Table 2
Natural gas distribution network operators (DNOs).

Panel A – Natural Gas DNOs by nature												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Not corporatized	69	64	16	3	3	3	3	3	2	1	1	1
Municipal	74	77	94	85	83	70	60	53	47	43	39	32
Partially privatized	9	12	15	16	17	17	13	13	11	13	14	12
Private	73	72	56	31	26	23	23	23	22	19	19	16
DNOs	216	213	166	119	112	96	86	79	71	63	59	49
Panel B – Served municipalities by nature of natural gas DNOs												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Not corporatized	70	65	16	3	3	3	3	3	2	1	1	1
Municipal	286	299	390	441	442	447	444	442	437	431	390	309
Partially privatized	47	82	141	194	209	202	199	198	196	200	199	168
Private	1049	1048	975	925	925	897	889	876	865	849	773	674
Municipalities	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984
Panel C – Size of natural gas DNOs												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Size [000,000]												
Mean	0.042	0.042	0.053	0.074	0.079	0.092	0.102	0.111	0.124	0.139	0.138	0.135
Standard deviation	0.131	0.133	0.161	0.198	0.207	0.217	0.232	0.244	0.316	0.338	0.327	0.341
Maximum	1.644	1.647	1.581	1.609	1.633	1.579	1.573	1.569	2.287	2.300	2.147	2.009
Minimum	0.0003	0.0003	0.0009	0.0028	0.0028	0.0010	0.0010	0.0010	0.0010	0.0010	0.0010	0.0009
DNOs	216	213	166	119	112	96	86	79	71	63	59	49
Panel D – *Extensions* to the transition period												
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Years												
0	126	123	86	63	60	46	36	31	27	20	18	14
1	0	0	2	3	3	2	4	1	1	1	0	0
2	78	74	63	31	27	26	22	22	22	24	23	20
3	0	1	1	2	2	3	5	6	5	5	4	2
4	11	14	13	15	15	14	14	14	11	10	11	10
5	1	1	1	5	5	5	5	5	5	3	3	3
DNOs	216	213	166	119	112	96	86	79	71	63	59	49

Panel A reports the number of DNOs by type, i.e., not corporatized, municipal and private, over time. Panel B reports the number of served municipalities by DNO type. Panel C illustrates the summary statistics of the DNO size, measured as the cumulative population of served municipalities. Panel D illustrates the number of DNOs enjoying *extensions* to the transition period established by the reform, by years of *extension* granted.

2, when the municipality is served by a DNO that serves at least 100 thousand customers, or supplies at least 100 million mc per year of natural gas and does not meet requirements (a) and (c); and it is set equal to 2, for municipalities served by DNOs with private *shareholders* accounting for at least 40% of the capital and not meeting requirement (a) and (b). In case the municipality is served by a DNO that meets more than one of the above mentioned requirements, the *extension* years are summed up along the met requirements.

4.2. Data on controls at the municipality level

To avoid spurious correlations and/or to mitigate the effect of confounding factors, some controls, measured at the municipality level, have been added to the model. It should be emphasized that local governments in Lombardy are homogeneous in terms of task duties and, as far as the institutional setting is concerned, they do not differ from their counterparts in other Italian regions. Aside from the population size, the only sources of heterogeneity refer to the financial and political aspects. The descriptive statistics of municipality controls are summarized in Table 3.

The financial indicator captures the fiscal budget concerns of local governments. The budget concern has been extensively identified as a determinant of local service restructuring. First, local privatization and outsourcing have been placed in relation to *fiscal stress* by public choice theorists. They consider public delivery in the absence of competition as the ideal context for self-interested politicians who are eager to win electoral support and reciprocate by sustaining inefficient government jobs (Lopez-de-Silanes et al., 1997; McGuire et al., 1987). Accordingly, *fiscal stress* is viewed as a beneficial condition that makes this interaction unsustainable. Second, the public administration theorists predict that *fiscal stress* spurs financial and operational reforms aimed at improving local service delivery (Levine et al., 1981; Rubin and Stein, 1990). Following both the theoretical lenses, a positive impact of *fiscal stress* on the probability of compliance with the reform is expected.

The variable employed (*Fiscal Stress*) is the ratio between current expenditures and current revenues, and if larger than 1, it detects a situation in which the municipality is facing *fiscal stress*. Data have been collected from the Department of Local Finance (Italian Ministry of Internal Affairs).

Table 3
Descriptive statistics of municipality characteristics.

Panel A – Population and *fiscal stress* indicator	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Population [000]												
Mean	6.418	6.369	6.318	6.428	6.491	6.540	6.592	6.651	6.736	6.838	6.981	6.716
Standard deviation	36.20	36.22	35.05	35.88	36.61	37.11	37.12	37.23	37.39	38.05	40.31	40.76
Maximum	1301	1305	1247	1272	1299	1309	1303	1300	1296	1307	1324	1240
Minimum	0.093	0.087	0.093	0.095	0.091	0.082	0.076	0.087	0.080	0.068	0.074	0.079
Fiscal Stress												
Mean	0.985	0.995	0.977	0.973	1.003	1.026	1.016	1.009	1.035	1.037	1.028	1.015
Standard deviation	0.084	0.087	0.099	0.092	0.109	0.217	0.157	0.120	0.133	0.155	0.149	0.152
Maximum	1.593	1.879	1.913	1.865	2.081	3.291	2.659	2.393	2.243	2.431	2.335	2.185
Minimum	0.266	0.386	0.309	0.449	0.398	0.405	0.532	0.432	0.143	0.476	0.561	0.552
Observations	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984
Panel B – Political variables	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Election year	197	104	50	1001	48	196	100	53	919	48	178	77
Left-wing	190	194	186	114	114	101	85	79	35	32	27	34
Civic list	982	983	968	1113	1112	1110	1101	1089	985	967	879	768
Observations	1405	1412	1381	1369	1370	1347	1336	1321	1304	1281	1164	984

Panel A reports the summary statistics of the municipality population size (*Population*) and *fiscal stress* (*Fiscal Stress*) for the municipalities observed over time. *Fiscal Stress* is measured as the ratio between current expenditures and current revenues. Panel B reports: the number of observed municipalities in which local elections have been held over time; the number of municipalities in which the local government is affiliated to left-wing parties; and the number of municipalities in which the local government is linked to a civic party.

The political indicators are for the purpose of controlling for ideology and the timing of election. Political factors have been found significant by the extant literature in explaining both liberalization and privatization (Duso, 2005; Pitlik, 2007; Bortolotti and Pinotti, 2008; Duso and Seldeslachts, 2010; Potrafke, 2010). In particular, progressive parties have been found to be less inclined to privatization, whereas evidence on the relationship between ideology and liberalization reforms is still mixed.

In this respect, the variables employed in the model are: *Left-Wing*, which takes a value of 1 when the local government is progressive, i.e., affiliated to left-wing parties; *Civic List*, which takes a value of 1 when a civic party or movement governs the city, i.e., a party that has no official connection to traditional national parties and that campaigns on local issues; and *Election Year*, which takes a value of 1 in the year of the local election. Data have been collected from the Archive of Local Elections (Italian Ministry of Internal Affairs).

5. Empirical strategy

Estimates are obtained through a discrete time duration model, which allows to capture not only the mere resistance to or compliance with the reform but also, in the latter case, the timing of the decision (Beck et al., 1998).[15] In doing so, it is possible to analyze the dynamic dimension of the process and to estimate the path dependence of the hazard of the decision (Kroszner and Strahan, 1999; Gonzalez-Gomez and Guardiola, 2009).[16] I discuss the empirical strategy choice in the following two remarks.

First, a premise of the methodology is that the shock in the regulatory framework due to the reform has led to all municipalities facing the same obligation. In 2000, all franchises previously awarded had been forced to expire within the 2005–2010 period (later postponed to the 2007–2012 period), according to the eligibility for time *extensions*.

Second, a cross-sectional analysis, although viable, would not have been appropriate. In the first place, explanatory variables are not time-invariant. This would have required choosing for each municipality the critical interval in which to measure them. In addition, by deciding on a single observation for each municipality, the information about the timing of the decision would have been lost, and the results could have been potentially misleading. Finally, the chance to take advantage of a panel allows to control for unobserved heterogeneity, by eventually incorporating the frailty into the model estimates.

[15] To estimate a survival model, one can consider time as continuous and accordingly choose one of the related available estimation methods, e.g., the Weibull and Cox proportional hazards model (Cox, 1972; Cameron and Trivedi, 2005). However, the units of analysis in this paper consist of municipalities observed yearly, that is, in a discrete way. Taking this into account requires choosing a discrete time duration model, i.e., a model in which the duration data are grouped, meaning that information on whether a unit has been awarded the gas distribution franchise is available in some discrete time intervals (with independent variables held constant within each interval). A discrete time duration model can be easily estimated by binary outcome analysis. A probit link can be employed to obtain the hazard rates. The only difference between the ordinary binary outcome and discrete time duration models is the presence of a time dependence in the specification of the latter (Beck et al., 1998).

[16] Time dependence in these models is crucial because it provides the correct baseline hazard function, i.e., the function of hazard rate in the absence of covariates. By allowing for the correct baseline hazard function, consistent and efficient estimates are produced, and insights on the dynamic of the process can be drawn. Time dependence is modeled by using cubic splines, which provide a smoothed version of the information that would be captured by time dummies (Beck et al., 1998). Cubic splines with 4– 7 equidistant knots are tested. The test has been performed via a comparison of the ROC areas for models with different numbers of knots. A cubic spline with seven knots provides the best fit for the data.

Municipality characteristics are added as controls in all of the specifications of the model. In sum, the resulting naïve model to be estimated is the following:

$$\begin{aligned} &CP^*_{it} = \alpha + \beta\, shareholder_{it} + \gamma\, extension_{it} + \delta X_{it} + \vartheta S_t + \varepsilon_{it} \\ &CP_{it} = 1 \text{ if } CP^* > 0 \\ &CP_{it} = 0 \text{ if } CP^* \leq 0 \end{aligned} \tag{5}$$

where the dependent variable CP^*_{it} is the conventional latent variable related to the observable binary index variable CP_{it} taking a value of 1 if the municipality *i* organizes a competitive procedure to award a new natural gas distribution franchise in the year *t* and 0 otherwise; *shareholder* is the explanatory variable of interest, a dummy equal to 1 if the municipality is a *shareholder* of the incumbent natural gas DNO operating the service in that municipality and 0 otherwise; *extension* is the *extension* to the transition period granted to the incumbent DNO – and indirectly to their served municipalities – ranging from 0 to 5 years; X_{it} is a vector of municipality controls; S_t is the vector encompassing the cubic spline of time; and ε_{it} is the error component.[17]

The model described thus far has been extended to address the endogeneity issue described in Section 1. First, the decisions to comply with the reform by organizing a competitive bidding procedure and to be a *shareholder* of the incumbent DNO may be interrelated. For instance, a local government can decide to enter the capital of the DNO when some unobservable reasons make it more likely to delay the competitive bidding procedure in its administered municipality. Second, as mentioned above, the time *extensions* for the transition period are directly related to the DNO characteristics, which may be strategically manipulated by local governments in the municipalities that are *shareholders* of incumbent DNOs to meet the time *extension* requirements and delay the competitive bidding procedure. This could be achieved by implementing restructuring measures that entail an increase in size of the DNO, e.g., M&A operations, and/or the entry of private *shareholders* in the capital of the municipally owned DNOs.

To overcome the abovementioned issues, I jointly estimate Eq. (5) with two additional equations; the first models the probability of being a *shareholder* of the incumbent DNO, and the second models the determination of the time *extension* to the transition period. The resulting model to be estimated becomes the following:

$$CP_{it} = 1(\alpha + \beta Shareholder_{it} + \gamma Extension_{it} + \delta_{CP} X_{it} + \vartheta_{CP} S_t + \varepsilon_{it} > 0) \tag{6}$$

$$Shareholder_{it} = 1(\pi_{Sh} Z_{it} + \delta_{Sh} X_{it} + \vartheta_{Sh} S_t + u_{it} > 0) \tag{7}$$

$$Extension_{it} = \pi_{Ext} Z_{it} + \delta_{Ext} X_{it} + \vartheta_{Ext} S_t + v_{it} \tag{8}$$

where Eq. (6) is the same as Eq. (5), except for the subscripts introduced to distinguish the coefficients of municipality controls and the cubic spline of time appearing in all of the three equations. Eqs. (7) and (8) are *shareholder* and *extension* equations, respectively. Aside from the municipality controls and cubic spline of time, they include a vector *Z* of exogenous variables that encompass the constant term, two macro-area dummies and the *extension* to the transition period for which the municipalities were eligible at the time the reform was passed in 2000. The selection of the instrumental variables is justified by the observation that Lombard *shareholder* municipalities, for historical reasons, are concentrated in the central area of the region – corresponding to the richest provinces of Milan, Bergamo and Brescia – while they are less frequent in the southern area – corresponding to the provinces of Pavia, Lodi, Mantua and Cremona. Obviously, the location is exogenous to the model of compliance developed here.

Additional tests have been performed to support the causal interpretation of the findings. First, the proposed identification assumes that the municipal *shareholders* of incumbent DNOs resist competition for the market because it is a credible threat to the dominant position held by the DNO in the municipal market. However, when local governments are, at the same time, owners of the incumbent and designers of the competitive procedures, the possibility that the threat is not highly credible cannot be ruled out. This issue has been addressed by estimating a model of incumbency. In this way, it has been verified that the probabilities of re-awarding the gas distribution franchise to the incumbent when the municipality is among its *shareholders* and when it is not are not significantly different.

Second, it has been assumed thus far that the decision made by each municipality is independent from any form of external influence. However, this assumption has to be dropped if one considers that municipalities served by the same DNO can imitate each other. If this imitation effect is actually in place, municipal *shareholders* may imitate each other to a greater degree than non-*shareholders* because of their ownership links, and the identification referring to Eq. (5) can deliver biased estimates.

The imitation effect among municipalities served by the same DNO may be due to a number of factors. First, certain municipalities served by the same DNO share gas infrastructure that includes not only local pipelines but also reduction and measure stations. Second, to minimize litigation costs, municipalities served by the same DNO can opt for organizing competitive procedures to award a bundle of gas distribution franchises. Litigation costs can arise before and after the competitive procedure, mainly for two reasons: i) The infrastructure has to pass through municipalities to be transferred from the incumbent DNO to the new entrant, and ii) the bid assessment entails a certain degree of discretion. Third, joint competitive procedures are often organized by *shareholder* municipalities owning the same DNO.

[17] There is a reason why I have sided for a dummy variable instead of using the capital share to measure the economic stake of each municipality in the DNO. Many sampled DNOs are held by several municipalities, in which they can operate the gas distribution service alongside other local public services. Very often the company does not operate all services in all shareholder cities and this is reflected by the ownership structure. Accordingly, the capital share may not be representative of the absolute economic stake the municipality holds in the gas distribution branch of the DNO.

I address this issue by including a "spatial effect" in the identification strategy (LeSage, 1999). Spatial effects are introduced by modeling a contemporaneous dependence structure using information on the distances among observations (included in a matrix). The resulting spatial model incorporates into the specification the decision made by the municipalities served by the same DNO – the so-called spatially lagged dependent variable. In such a way, the spatially lagged dependent variable can be thought of as controlling for the imitation effect.

The resulting model is an upgrade of the one displayed in Eq. (5) and takes the following form:

$$CP_{it} = 1\left(\alpha + \rho W_{it} CP^{*} + \beta\, shareholder_{it} + \gamma\, extension_{it} + \delta X_{it} + \varphi Z_{it} + \vartheta S_{t} + \varepsilon_{it} > 0\right) \quad (9)$$

where the matrix W is a "DNO cluster matrix" in which the element w_{ij} takes a value of 1 if observations i and j refer to municipalities served by the same DNO in a given year and 0 otherwise; CP^{*} is the vector of the latent variable related to the observable binary index CP. A positive value for the parameter associated with the spatial lag, i.e., ρ, indicates that the municipalities are expected to experience a higher (lower) hazard of awarding the gas distribution franchise if, on average, the municipalities served by the same DNO have (not) done so.

6. Results

6.1. Base model

Table 4 presents the results of the base model, i.e., the one referring to Eq. (5). The reported results refer to a discrete time duration model, estimated via probit regression, for which a cubic spline of time has been added to control for the path dependence of the hazard rate. Municipalities exit the dataset in the year following the one in which they have organized a competitive procedure, if they in fact do so; otherwise, they are right censored at the year 2012.

In columns 1 and 2 of Table 4, I report estimates controlling only for the *extension* to the transition period granted to the incumbent DNO, i.e., *extension*. In columns 3 and 4, I control also for the population size of the municipality, *Population*, the degree of *fiscal stress* faced by each municipality, *Fiscal Stress*, and the variables accounting for political aspects, i.e., the year of local election, *Election Year*, and the party affiliation of the local government, *Left-Wing* and *Civic-List*. Because I study the length of time spent by a municipality before organizing a competitive procedure and the explanatory variable of interest is defined at the municipality level, I allow for correlation of residuals within municipalities by clustering standard errors at that level.

The effect of the role of *shareholder* on the decision to award the gas distribution franchise is negative and statistically significant at the 5% level for the specification reported in columns 1 and 2 and at the 1% level for the specification reported in columns 3 and 4. These results indicate that municipalities holding capital shares of the incumbent natural gas DNO experienced a decrease in the hazard rate of awarding the gas distribution franchise if compared with the municipalities served by DNOs in which they do not hold any shares. The magnitude of the effect, measured using the estimates in column 3, implies a difference in the average hazards between non-*shareholder*s and *shareholders* by nearly 0.6% (see column 4). Given that the predicted average hazard rate for non-*shareholders* is 1.4%, shareholding leads to a reduction in the hazard rate by approximately 43%.

A concern that may be raised regarding the interpretation of the estimates in Table 4 stems from the effect of unobserved heterogeneity, commonly known as "frailty" in the duration model context. As long as frailty can be assumed to be distributed independently of time and the covariates, it may be incorporated into the model to take into account the hazard resulting from the differences among municipalities not captured by the explanatory variables. Unobserved heterogeneity can be due to political factors not controlled for by the variables included in the models, levels of service in gas distribution experienced by each municipality, and any other context-specific factor having an impact on the decision to comply or not with the reform. In any event, frailty is not found to be an issue if assumed to be both normally distributed and gamma distributed in models estimated via probit, logit and cloglog links (see Table A.1 in Annex).

6.2. Controlling for endogeneity

As explained in Section 5, both the variables *shareholder* and *extension* are supposed to be endogenous to the decision to comply with the reform. Endogeneity has been addressed by jointly estimating Eqs. (6)–(8), of which the last two are instrumental equations with municipality controls, cubic spline of time and a set of instrumental variables as covariates. The instrumental variables are two dummies controlling for the municipality location after having split the regional territory into three macro-areas, and the number of years granted as a time *extension* to the transition period in 2000, i.e., before the DNOs could implement restructuring measures meant to increase the transition period for the served municipality.

Panel A of Table 5 reports the estimates of Eq. (6) with and without municipality controls in the specification of the model. Columns 1 and 3 report the coefficients, while columns 2 and 4 report the average marginal effects. Panel B, instead, reports the estimates of Eqs. (7) and (8) obtained by jointly estimating them with the corresponding main equation.

The instruments have been tested in two steps. The first step consisted of testing the exclusion restriction of all instruments in each of the two instrumental equations to assure that they are correlated with the instrumented variables. The second step required a test of the exclusion restriction of all instruments after the OLS of residuals in Eq. (6) against the instruments – controlling for municipality controls and cubic spline of time - to guarantee no correlation between the errors and instruments.[18]

[18] Pearson residuals have been computed after the probit estimation of Eq. (6).

Table 4
Discrete time duration estimates.

	(1) Coeff.	(2) Marginal effects	(3) Coeff.	(4) Marginal effects
Shareholder	−0.1503**	−0.0046**	−0.2064***	−0.0060***
	(0.0754)	(0.0021)	(0.0782)	(0.0019)
Extension	−0.0618***	−0.0021***	−0.0654***	−0.0022***
	(0.0186)	(0.0006)	(0.0186)	(0.0006)
Population			−0.0003	−0.0000
			(0.0005)	(0.0000)
Fiscal Stress			−0.0707	−0.0024
			(0.1654)	(0.0055)
Election year			−0.2323***	−0.0066***
			(0.0750)	(0.0018)
Left-wing			0.0751	0.0027
			(0.0998)	(0.0038)
Civic list			−0.2045***	−0.0078***
			(0.0602)	(0.0026)
Constant	−3.7825***		−3.4413***	
	(0.2878)		(0.3175)	
Cubic splines	0.7824***		0.7100***	
	(0.1388)		(0.1290)	
	−7.7080***		−6.0127***	
	(1.7737)		(1.7252)	
	34.718***		24.510***	
	(8.8079)		(8.9947)	
	−39.319***		−26.419**	
	(10.013)		(10.641)	
	29.980***		22.466***	
	(5.2902)		(5.9850)	
	−40.337***		−35.331***	
	(4.3082)		(4.6514)	
Observations	15,674	15,674	15,674	15,674
Municipalities	1418	1418	1418	1418

The table reports the results of discrete time duration estimations obtained via probit regressions and including in the specification a cubic spline of time, computed using seven equidistant knots. The dependent variable is binary, equal to 1 if the municipality organizes a competitive procedure to re-award the gas distribution service and 0 otherwise. The explanatory variable of interest is *shareholder*, a dummy equal to 1 if the municipality is a *shareholder* of the DNO currently operating the service and 0 otherwise. *Extension* measures the number of years granted to the current DNO as an *extension* to the transition period established by the reform and is always included. Depending on the specification, the models control for the population size of the municipality, *fiscal stress*, election year and party affiliation of the local government. Coefficients and average marginal effects are reported. Standard errors (clustered by municipalities) are reported in parentheses. * Significance at 10%.

** Significance at 5%.

*** Significance at 1%.

Both tests produced the expected results, i.e., correlation between instruments and the instrumented variable and no correlation between the instruments and errors.

The magnitude of the effect of the role of *shareholder* on the hazard of awarding gas distribution franchises increases as endogeneity is controlled for. It remains negative and statistically significant (although at the 5% level) for the specifications reported in columns 3 and 4 of Table 5. The effect loses significance, instead, when municipality controls are excluded. If the estimates reported in column 4 are considered, *shareholder* municipalities are found to experience a decrease in the hazard rate of awarding by nearly 0.82% if compared with the municipalities served by DNOs in which they do not hold shares.

Both estimates in columns 1 and 2 and columns 3 and 4 indicate a sharp increase in the effect of the number of years granted as a time *extension* to the transition period. These results seem to suggest that DNOs (preferably municipally owned), which have implemented restructuring measures resulting in an *extension* of the transition period, have not done so to protect themselves from competition but rather to eventually obtain efficiency gains and increase the chance of winning the competitive procedure that their served municipalities should organize.

7. Further causal validations

In this section, the previous analysis is extended to accommodate the two identification challenges discussed in Section 5. The estimation methods and some additional tests described here support a causal interpretation of the findings in Section 6.

Table 5
Controlling for endogeneity.

Panel A – Main equation	(1) Coeff.	(2) Marginal effects	(3) Coeff.	(4) Marginal effects
Shareholder	−0.6236	−0.0160	−0.2900*	−0.0082**
	(0.8047)	(0.0179)	(0.1519)	(0.0036)
Extension	−0.2491	−0.0094	−0.1534***	−0.0053***
	(0.2224)	(0.0106)	(0.0391)	(0.0014)
Municipality controls	No	No	Yes	Yes
Cubic splines	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Panel B – Instrumental equations	(1)	(2)	(3)	(4)
	Dependent variable: *shareholder*		Dependent variable: *extension*	
Extension in 2000	−0.9972***	−1.0291***	0.7193***	0.7181***
	(0.0744)	(0.0621)	(0.0134)	(0.0134)
Northern area	−0.1786	−0.0215	0.0796	0.0710
	(0.1482)	(0.1558)	(0.0504)	(0.0508)
Southern area	−0.7275***	−0.6106***	−0.0219	−0.0278
	(0.1268)	(0.1361)	(0.0534)	(0.0538)
Municipality controls	No	Yes	No	Yes
Cubic splines	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Observations	15,674	15,674	15,674	15,674
Municipalities	1418	1418	1418	1418

Panel A reports the results of the discrete time duration estimations obtained controlling for the endogeneity of *shareholder* and *Extension*. Depending on the specification, the models control for the population size of the municipality, *fiscal stress*, election year and party affiliation of the local government. Both coefficients and average marginal effects are reported.
Panel B reports the estimated coefficients of the first-step equations. Columns 1 and 2 displays the probit estimates of the *shareholder* equation, with and without municipality controls; columns 3 and 4 displays the OLS estimates of the *extension* equation, with and without municipality controls. Equations relative to columns 1 and 3 are estimated along the equation in column 1 of Panel A. Equations relative to columns 2 and 4 are estimated along the equation in column 3 of Panel A. Cubic splines of time and a constant term are included (coefficients not reported). Standard errors are reported in parentheses.

* Significance at 10%.
** Significance at 5%.
*** Significance at 1%.

7.1. Credibility of competition for the market

A concern with the interpretation of the results reported in Tables 4 and 5 is the possibility that the threat posed by the awarding of a new gas distribution franchise – even when it takes place – is not highly credible. The data indicate that the gas distribution franchises have been re-awarded to the incumbent in 222 cases out of 356 (62%). The credibility of competitive procedures is an even greater concern when the franchising authority is at the same time a *shareholder* of the incumbent DNO. If the *shareholder* municipalities bestowed an advantage to the DNOs in which they hold capital shares, the link between the resistance to competition for the market and the rent protection of the *shareholder* municipality would become barely supportable.

The results reported in Table 6 rule out this possibility. Columns 1 and 2 and 3 and 4 refer to two different specifications of an incumbency model. The estimates refer to a Heckman selection model used to control for selection in the group of municipalities compliant with the reform, i.e., municipalities that have awarded the gas distribution service via competitive bidding. The dependent variable is a binary variable equal to 1 if, in the case of the competitive procedure, the incumbent wins the franchise and is confirmed as the natural gas DNO in the municipality and 0 otherwise. Exclusion restrictions are the *extension* to the transition period (*extension*), municipality controls and cubic splines of time for the specifications in columns 1 and 2; municipality controls are not excluded in the specification relative to columns 3 and 4. Municipalities served by non-corporatized DNOs have been dropped from the sample because non-corporatized DNOs are not allowed to participate in competitive procedures.

As columns 2 and 4 indicate, the coefficients of the variable *Shareholder* are not statistically significant in both specifications of the incumbency model. This suggests that municipalities holding a capital share in an incumbent DNO have granted no significant advantages to them when a competitive procedure has been organized. In other words, competition for the market does not suffer from a "credibility gap" when *shareholder* municipalities as franchising authorities award a new franchise.

Table 6
Incumbency model to test credibility of competition for the market.

	(1) Selection	(2) Incumbency	(3) Selection	(4) Incumbency
Shareholder	−0.3687***	0.2283	−0.3627***	0.2412
	(0.0902)	(0.1782)	(0.0905)	(0.1932)
Extension	Yes	No	Yes	No
Municipality controls	Yes	No	Yes	Yes
Cubic splines	Yes	No	Yes	No
Constant	Yes	Yes	Yes	Yes
Selected observations		356		356
Observations	15,503	15,503	15,503	15,503
Municipalities	1395	1395	1395	1395

The table reports the results of an incumbency model aimed at testing the credibility of competition for the market as a regulatory tool. Estimates refer to a Heckman selection model used to control for selection in the group of municipalities compliant with the reform, i.e., municipalities that have awarded the gas distribution service via competitive bidding. The dependent variable is a binary variable equal to 1 if, in the case of the competitive procedure, the incumbent wins the franchise and is confirmed as the natural gas DNO in the municipality and 0 otherwise. The exclusion restrictions are: the *extension* to the transition period (*extension*), the municipality controls and cubic splines of time in Specification (1 and 2); and the *extension* to the transition period and cubic splines of time in Specification (3 and 4). Municipalities served by non-corporatized DNOs have been dropped from the sample because they are not allowed to participate in the competitive procedures. Standard errors (clustered by municipalities) are reported in parentheses. *Significance at 10%. ** Significance at 5%.

*** Significance at 1%.

7.2. Controlling for "spatial" effects

As explained in Section 5, municipalities may base their decisions regarding the award of the gas distribution franchise on the same decisions made by other municipalities. This can be due to the "imitation effect" among municipalities served by the same DNO. If this is the case, municipal *shareholders* may imitate each other more than non-*shareholders* because of their ownership links, and Eq. (5) can deliver biased estimates.

I have estimated the spatial model illustrated by Eq. (9) in Section 5. The method employed to address the spatial serial correlation, in a binary outcome context, is the Klier-McMillen linearized GMM probit model (Klier and McMillen, 2008).[19,20]

The W matrix in Eq. (9) has been row-standardized, so that each row belonging to non-isolated observations sums to 1; thus, the spatial lag of the dependent variable for each observation proves to be the average value of that variable measured in correspondence to the observations referring to the municipalities served by the same DNO in a given year. Thus, one can think of the spatially lagged model as analogous to an autoregressive time series model in which temporal serial correlation is addressed by including a lagged dependent variable in the specification.

The estimation results are reported in Table 7. Columns 1 and 2 refer to two specifications – with and without municipality controls - estimated using the probit link. Column 3 refers to the same model estimated by using, in place of *shareholder* and *extension*, the predicted value from Eqs. (7) and (8), respectively.

As indicated by the significance of *Rho*, the spatial effects are in place and shape the decision to comply with the reform to a great extent. The coefficient of *shareholder* preserves sign and statistical significance at the 1% level in all of the three specifications. However, the magnitude of the *shareholder* effect in the spatial model splits into a direct and an indirect effect, with the latter due to the chain reaction induced by the spatially lagged term. The direct effect decreases, in absolute terms, if compared with the one obtained by estimating the model without the spatial effect (see column 3 in Table 5). Nevertheless, when the indirect effect is considered as well, the estimated equilibrium effect implies a reduction in the hazard of awarding by nearly 91% when a municipality is a *shareholder* of the incumbent DNO, compared to a reduction by 63% when the estimate is performed without controlling for spatial effects (see Section 6.2). Fig. 1 shows a comparison between the endogeneity-robust model (column 3 in Table 5) and the spatial model (column 3 in Table 7), by plotting the simulated time dependence of the hazard rate of reform compliance.

8. Conclusions

Using a novel identification based on an exogenous change in the regulatory framework of the Italian gas distribution market – making competitive bidding to award gas distribution franchises compulsory at the municipality level – the paper establishes a relationship between public ownership and regulatory outcomes.

[19] The spatial model has been estimated using R package McSpatial. All the previous specifications, instead, have been estimated with Stata 12.

[20] The linearized model is a three-step estimation procedure. Let y be the indicator value: $y = 1$ when $y^* > 0$ and $y = 0$ when $y^* < 0$. The first stage is standard probit of y on X. The probability estimates from this regression are $p = \varphi(X\beta)$ and the generalized error is $e = (y - p)^*\varphi(X\beta)/(p(1-p))$. The second/third stage of the procedure is standard 2SLS estimation of $u = e + gX\beta$ on gX and $gWX\beta$ using X and WX as instruments, where g is the gradient vector, $-de/d\beta$.

Table 7
Incorporating the "spatial effect".

	(1) Simple probit	(2) Simple probit	(3) Two-stage estimation
Shareholder	−0.2378***	−0.2580***	−0.1997***
	(0.0375)	(0.0406)	(0.0148)
Extension	−0.0270***	−0.0270***	−0.3822***
	(0.0097)	(0.0101)	(0.0236)
Rho	0.4148***	0.4061***	0.2771***
	(0.0347)	(0.0333)	(0.0321)
Municipality controls	No	Yes	Yes
Cubic splines	Yes	Yes	Yes
Constant	Yes	Yes	Yes
Observations	15,674	15,674	15,674
Municipalities	1418	1418	1418

The table reports the results of the discrete time duration estimations obtained via probit regressions after having controlled for the "spatial effect". Observations are connected in the cases of municipalities served by the same DNO. Cubic splines of time as well as a constant term are included in the Specification 1. Municipality controls are added in Specification 2 (coefficients are not reported). *Shareholder* and *Extension* variables are replaced with predicted values of Eqs. (7) and (8) in Specification 3. Standard errors are reported in parentheses. * Significance at 10%. ** Significance at 5%.
*** Significance at 1%.

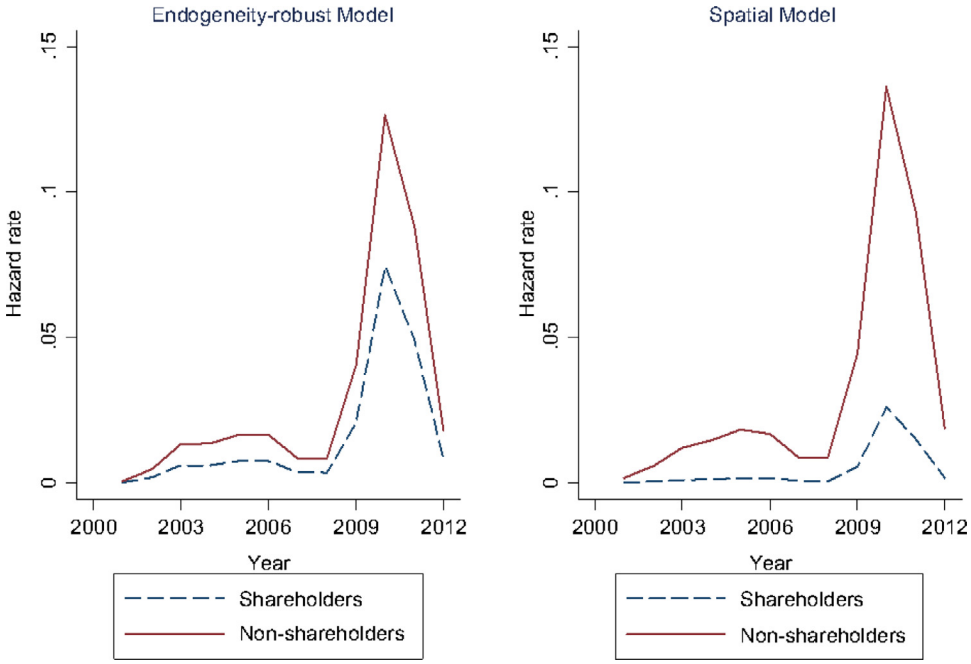

Fig. 1. Simulated time dependence for *shareholders* and non-*shareholders*. The figure plots the hazard rates overtime, estimated by using results of the endogeneity-robust model in column 3 of Table 5 and the spatial model in column 3 of Table 7, for non-*shareholder* municipalities (solid line) and *share-holder* municipalities (dashed line). Simulated hazard rates have been obtained by allowing only the variables encompassing the cubic splines of time to vary and setting the remaining part of the models at their predicted means.

The estimates provided by the analyses suggest that when a municipality is the *shareholder* of the incumbent DNO, the hazard of awarding the gas distribution franchise decreases. This finding is consistent with results of the extant studies on the effect of public ownership on the regulatory outcomes in EU countries (Bortolotti et al., 2011, 2013; Edwards and Waverman, 2006).

The empirical strategy proposed in the paper offers several advantages. First, by exploiting a change in the regulatory framework that makes all decision makers (the municipalities as regulators) have the same obligations, it is possible to avoid potential endogeneity problems stemming from the simultaneity of regulatory reform and public ownership. Second, by taking advantage of a reform targeted at municipalities, I can use a large sample and elude problems stemming from heterogeneity of contexts and institutional arrangements that plague studies conducted at the national level. Third, by using a duration model, I can take into account not only the resistance to the reform by municipalities that are not compliant at all but also the resistance by municipalities that delay compliance.

The results provided by the analyses of this paper are relevant for the debate on the institutional arrangements that have to be put in place to regulate the markets in which the state, at different levels of government, retains an economic stake. A number of works have emphasized the relevance of regulatory independence, which is subject to the institutional settings affecting the separation of powers, including an effective system of "checks and balances" among the different bodies through which democracy is made effective, the political system, i.e., the rules regulating elections and parties systems, and the enforcement of norms and rules (Levy and Spiller, 1994; Bortolotti et al., 2013).

All of them have concluded that a case for regulatory failure exists in contexts in which strong publicly controlled incumbents dominate the network industries. This issue is exacerbated when the dispersion of public ownership and regulatory powers among different levels of government, including the national, regional and municipal, makes the separation of the two roles unlikely. The Italian case of the gas distribution sector is emblematic and raises concerns about the effectiveness of European privatization and regulatory policy in the network industries. To address the problem and therefore to improve the credibility of the recent structural reforms of public services and network industries, national governments face two options: i) push forward privatization to eliminate the potential conflict of interest; and ii) improve regulatory institutions to allow for increased independence and public accountability.

It should be emphasized that this paper does not focus on the relationship between the dispersion of regulatory powers and regulatory outcome in the presence of the municipal ownership of regulated firms. This would have required a comparison of the different institutional settings, e.g., countries characterized by different degrees of dispersion of the regulatory powers. On the contrary, the dispersion of regulatory powers constitutes the institutional context that frames the analysis of this paper and that has thus far drawn scarce attention in the literature.

Analyzing the welfare effects of delaying the awarding of gas distribution franchises is beyond the scope of this paper. However, it may be argued that the resistance to competition for the market by *shareholder* municipalities reduces welfare overall. Municipally owned DNOs tend to be less efficient. Hence, resistance to the reform could serve to transfer rents from the most efficient DNOs, which can be considered as potential winners of the potential competitive procedures, to the least efficient incumbent DNOs. The ensuing welfare reduction is mitigated to the extent that municipally owned DNOs use the rent to increase their long-run efficiency.

Acknowledgments

I am grateful to Carlo Cambini, Paola Garrone, Luca Grilli, Sergio Mariotti, Teresa Romano and two anonymous referees for proof reading the article and providing useful comments and suggestions. All errors remain my own.

Annex

Table A1.

Table A.1
Incorporating unobserved heterogeneity (frailty).

	(1) Normal frailty probit link	(2) Normal frailty logit link	(3) Normal frailty cloglog link	(4) Gamma frailty cloglog link
Shareholder	−0.2065**	−0.5256***	−0.5129***	−0.5127***
	(0.0855)	(0.1897)	(0.1822)	(0.1833)
Extension	−0.0654***	−0.1543***	−0.1488***	−0.1488***
	(0.0217)	(0.0476)	(0.0454)	(0.0459)
Municipality controls	Yes	Yes	Yes	Yes
Cubic splines	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes
Sigma_u	0.0024	0.0060	0.0064	0.0000
	(0.0165)	(0.0491)	(0.0493)	(0.0017)
LR test				
Chibar2(1)	0.0002	0.0002	0.0002	0.0000
Prob > Chibar2(1)	0.495	0.494	0.494	1.000
Observations	15,674	15,674	15,674	15,674
Municipalities	1418	1418	1418	1418

The table reports the results of the discrete time duration estimations obtained via panel binary outcome regressions to control for unobserved heterogeneity at the municipality level (or frailty). Only coefficients are reported. Columns 1–3 report the results of models that assume normal frailty estimated via panel probit, logit and cloglog regressions, respectively. Column 4 reports the results assuming gamma frailty and a cloglog link. The LR tests aimed at comparing models with and without frailty are displayed at the bottom of each column. The municipality controls and cubic splines of time as well as a constant term are included (coefficients are not reported). Standard errors are reported in parentheses. * Significance at 10%.

** Significance at 5%.

*** Significance at 1%.

References

Armstrong, Mark, Sappington, David E.M., 2006. Regulation, competition and liberalization. Journal of Economic Literature 44, 325–366.
Armstrong, Mark, Sappington, David E.M., 2007. Recent developments in the theory of regulation. Handbook of Industrial Organization 3, 1557–1700. Baldwin, Robert, Cave, Martin, 1999. Understanding Regulation. Theory, Strategy and Practice. Oxford University Press, Oxford, UK.
Baron, David P., Myerson, Roger B., 1982. Regulating a monopolist with unknown costs. Econometrica, Journal of the Econometric Society 50 (4), 911–930. Beck, Nathaniel, Katz, Jonathan N., Tucker, Richard, 1998. Taking time seriously: time-series-cross-section analysis with a binary dependent variable. American Journal of Political Science 42 (4), 1260–1288.
Besley, Timothy, Coate, Stephen, 2003. Elected versus appointed regulators: theory and evidence. Journal of the European Economic Association 1 (5), 1176–1206.
Bortolotti, Bernardo, Cambini, Carlo, Rondi, Laura, 2013. Reluctant regulation. Journal of Comparative Economics 41 (3), 804–828.
Bortolotti, Bernardo, Cambini, Carlo, Rondi, Laura, Spiegel, Yossi, 2011. Capital structure and regulation: do ownership and regulatory independence matter? Journal of Economics & Management Strategy 20 (2), 517–564.
Bortolotti, Bernardo, Faccio, Mara, 2009. Government control of privatized firms. Review of Financial Studies 22 (8), 2907–2939.
Bortolotti, Bernardo, Fantini, Marcella, Siniscalco, Domenico, 2003. Privatization around the world: evidence from panel data. Journal of Public Economics 88 (1–2), 305–332.
Bortolotti, Bernardo, Pinotti, Paolo, 2008. Delayed privatization. Public Choice 3, 331–351.
Cambini, Carlo, Rondi, Laura, 2011. Regulatory Independence, Investment and Political Interference. Evidence from the European Union EUI working papers. RSCAS 2011/42, Florence.
Cameron, A. Colin, Trivedi, Pravin K., 2005. Microeconometrics. Cambridge University Press, Cambridge, UK.
Conway, Paul, Nicoletti, Giuseppe, 2006. Product Market Regulation in the Non-manufacturing Sectors of OECD Countries: Measurements and Highlights. OECD, Paris OECD Economics Department working paper no. 530.
Cox, David R., 1972. Regression models and life tables (with discussion). Journal of the Royal Statistical Society: Series B 34, 187–220.
Cox, Gary W., McCubbins, Mathew D., 1986. Electoral politics as a redistributive game. The Journal of Politics 48 (02), 370–389.
Demsetz, Harold, 1968. Why regulate utilities? Journal of Law and Economics 11, 55–66.
Dinç, I. Serdar, 2005. Politicians and banks: political influences on government-owned banks in emerging markets. Journal of Financial Economics 77 (2), 453–479. Dinc, I. Serdar, Gupta, Nandini, 2011. The decision to privatize: finance and politics. The Journal of Finance 66 (1), 241–269.
Duso, Tomaso, 2005. Lobbying and regulation in a political economy: evidence from the U.S. cellular industry. Public Choice 122, 251–276.
Duso, Tomaso, Seldeslachts, Jo, 2010. The political economy of mobile telecommunications liberalization: evidence from OECD countries. Journal of Comparative Economics 38 (2), 199–216.
Edwards, Geoff, Waverman, Leonard, 2006. The effects of public ownership and regulatory independence on regulatory outcomes. Journal of Regulatory Economics 29 (1), 23–67.
Garrone, Paola, Marzano, Riccardo, 2014. Why do Local Governments Resist Contracting out? Urban Affairs Review doi:1078087414549548
Gonzalez-Gomez, Francisco, Guardiola, Jorge, 2009. A duration model for the estimation of contracting out of urban water management in southern Spain. Urban Affairs Review 44 (6), 886–906.
Guerriero, Carmine, 2011. Accountability in government and regulatory policies: theory and evidence. Journal of Comparative Economics 39, 453–469.
Hauge, Janice A., Jamison, Mark A., Prieger, James E., 2012. Oust the louse: does political pressure discipline regulators? Journal of Industrial Economics 60 (2), 299–332.
Henisz, Witold J., 2000. The institutional environment for economic growth. Economics and Politics 12 (1), 1–31.
Henisz, Witold J., Zelner, Bennet A., 2001. The institutional environment for telecommunications investment. Journal of Economics and Management Strategy 10 (1), 123–147.
Klier, Thomas, McMillen, Daniel P., 2008. Clustering of auto supplier plants in the United States. Journal of Business & Economic Statistics 26 (4), 460–471.
Kroszner, Randall S., Strahan, Philip E., 1999. What drives deregulation? Economics and politics of the relaxation of bank branching restrictions. The Quarterly Journal of Economics 114 (4), 1437–1467.
LeSage, James P., 1999. Spatial Econometrics. Regional Research Institute, West Virginia University.
Levine, Charles H., Rubin, Irene S., Wolohojian, George G., 1981. Resource scarcity and the reform model: the management of retrenchment in Cincinnati and Oakland. Public Administration Review 41 (6), 619–628.
Levy, Brian, Spiller, Pablo T., 1994. The institutional foundations of regulatory commitment: a comparative analysis of telecommunications regulation. Journal of Law, Economics and Organizations 10 (2), 201–246.
López-de-Silanes, Florencio, Shleifer, Andrei, Vishny, Robert W., 1997. Privatization in the United States. RAND Journal of Economics 28 (3), 447–471.
Martimort, David, 1999. The life cycle of regulatory agencies: dynamic capture and transaction costs. The Review of Economic Studies 66 (4), 929–947.
McGuire, Robert, Ohsfeldt, Robert, Van Cott, T. Norman, 1987. The determinants of the choice between public and private production of publicly funded service. Public Choice 54 (3), 211–230.
Pitlik, Hans, 2007. A race to liberalization? Diffusion of economic policy reform among OECD-economies. Public Choice 132, 159–178.
Potrafke, Niklas, 2010. Does government ideology influence deregulation of product markets? Empirical evidence from OECD countries. Public Choice 143 (1–2), 135–155.
Riordan, Michael H., Sappington, David E.M., 1987. Awarding monopoly franchises. The American Economic Review 77 (3), 375–387.
Rubin, Irene S., Stein, Lana, 1990. Budget reform in St. Louis: why does budgeting change? Public Administration Review 50 (4), 420–426.
Sappington, David E.M., Sidak, J. Gregory, 2003. Incentives for anticompetitive behavior by public enterprises. Review of Industrial Organization 22 (3), 183–206.
Shleifer, Andrei, Vishny, Robert W., 1994. Politicians and firms. The Quarterly Journal of Economics 109 (4), 995–1025.
Spiegel, Yossi, Spulber, Daniel, 1994. The Capital Structure of a Regulated Firm. RAND Journal of Economics 25 (3), 424–440.
Verdier, Axelle, 2004. Local Public Companies in the 25 Countries of the European Union, Dexia edition Paris, France.