Provision and production reform of urban fire services:

Privatization, cooperation and costs

Germà Bel [φ] & Alejandro Belerdas-Castro [φ]

[φ] Universitat de Barcelona and OAP-UB

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Corresponding author:
Germà Bel. Department of Econometrics, Statistics and Applied Economics (Public Policy Section). School of Economics and Business, Universitat de Barcelona.
St. John Keynes 1-11,
08034 Barcelona, Spain
e-mail: gbel@ub.edu
ORCID: https://orcid.org/0000-0002-1330-8085
Twitter: @gebelque

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Abstract

With the objective of expanding fire protection services to cover sparsely populated areas, an important reform has been implemented in the region of Galicia (Spain) over the two last decades, involving cooperation at county level and provincial level for service provision, and privatization of the service production. This article analyses that reform, and empirically studies whether privatization and cooperation have had any significant effect on costs incurred by the government for fire service provision. Our results suggest that cooperation is an efficient tool for expanding the service. However, we do not find a significant relationship between privatization and costs.

Keywords: fire services; privatization; inter-municipal cooperation; local public services

JEL Codes: L32; L33; O38

Introduction

Using privatization as a tool for reforming the production of local public services has been a widely implemented policy in many countries. Privatization has affected most services provided by local governments, with special intensity in technical services such as waste collection, water distribution, legal services and, to a lesser extent, social services. Abundant evidence is available in the literature, and several meta-analyses, some using meta-regression techniques, examine factors that explain why governments have decided to privatize (Bel and Fageda, 2007), and the economic effects of local privatization (Bel and Warner, 2008; Bel, Fageda and Warner, 2010; Petersen, Hjelmar and Vrangbæk, 2015; Overman, 2016; Andersson, Jordahl and Josephson, 2019). Fiscal constraints and hopes for cost reduction

appear to be the main drivers of privatization. However, the most recent empirical studies on privatization and costs tend to find no systematic association between them, and that the results are largely dependent on the specific case. Particularly when relevant contracting difficulties are involved, such as those originating from transaction costs and contract incompleteness.

Fire services have singular features that make them substantially different from most local public services. Brueckner (1981), in a seminal analysis of congestion effects of fire services, found the congestion properties to be very similar to those of a pure public good, thus resulting in a high degree of publicness. Fire services operate under conditions of fluctuating and uncertain demand (Blåka, 2017a). Excess capacity is frequent, reflecting a 'fail safe' system designed with the purpose of protecting citizens from unpredictable risk situations whose associated costs would be very high (Blåka, 2017a, 2017b).

Fire services are characterized by relevant asset specificity: fire stations, dedicated vehicles and a highly specialized workforce (Brown and Potoski, 2005; Hefetz and Warner, 2012), and measuring service provision and quality is problematic (Brown and Potoski, 2005; Hefetz and Warner, 2012; Holmgren and Weinholt, 2016; Blåka, 2017a). Hence, managing contracts in this sector is difficult (Hefetz and Warner, 2012). Furthermore, fire service regulations usually impose strict limits on the maximum distance from fire station to populated areas, to guarantee a certain response time in case of emergency (Blåka, 2017a), which can make it difficult to set the optimal operational scale. Thus, spatial differences in the level of service provision are usually important (KC, Corcoran and Chhetri, 2020).

Unlike other local public services, fire protection has remained largely untouched by reforms intended to promote private production of firefighting services. Although private arrangements for fire protection of industrial factories and equipment ('industrial safety') exists in many countries (Lethbridge, 2009), the contracting of private firms by local governments is prevalent only in Denmark, where a large company, Falck, produces this service in most municipalities

(Hansen, 1988; Gadet, 2009). To a lesser extent, local governments also contract private firms for fire services in the US, particularly in Arizona, Georgia, Illinois, Oregon and Tennessee (Johnston, 2001). The firm Rural/Metro Corporation is the major private provider of such services to local governments. Another interesting exception to the lack of private involvement in local fire services is Slovakia where, while it is legally possible for municipalities to contract to private firms, this rarely happens, although two private companies, ZHZ and ZHÚ, provide fire services to factories and utilities (Marcinek and Hajdúková, 2017; Chromek and Mračková, 2018).

The Spanish north-western region of Galicia has undergone an intensive process of privatization of local fire services in the two last decades, after which a complex management system exists nowadays in the region. On the one hand, public and private production coexist all over the region. On the other hand, municipal stand-alone units and inter-municipal units also coexist throughout the region; some of these last operating under the auspices of inter-municipal county-cooperation, but most of them operating at province level. For our study, we take full advantage of the information offered by this complex organization of firefighting services. We characterize and analyse the processes of service expansion and reform undertaken in Galicia, an under-researched case, thus providing a first contribution to the literature.

Moreover, we have been able to gather a rich dataset including demographic, institutional, cost-related and other service-related data. Based on that dataset, we have built a data panel for 2010-2018, which we analyse with econometric techniques. This allows us to analyse the factors that explain differences in costs incurred by the various municipal and collaborative units in the region. More specifically, we are interested first in ascertaining whether there is a cost difference between publicly and privately produced services. In this way, we provide a relevant contribution to the literature, conducting a multivariate analysis of public versus

private cost in local firefighting services, the only precedent for which is Kristensen (1983), who found that in Denmark private production was less costly than public production.

Furthermore, our empirical analysis allows us to study the effect of cooperative provision on the costs of fire services. This issue has been empirically analysed by Holmgren and Weinholt (2016) for Sweden, Blåka (2017a) for Norway, and Aldag, Warner and Bel (2020) for the US. In all three studies only cooperation was considered, most likely because intermunicipal cooperation is only compatible with public production in those three countries. Here we take advantage of the possibility of combining cooperative provision with private production in our institutional context, so that we can disentangle the effects of choices of provision (single versus cooperative) and production (public versus private) on costs. To our knowledge only one previous study has conducted an analysis of this kind, for solid waste collection (Bel, Fageda and Warner, 2014); thus, our research provides an additional contribution to the literature, which goes beyond the intrinsic interest of analysing fire services.

The rest of the paper is organized as follows. Next, we review the theoretical literature on privatization and cooperation of local public services and related costs, after which we review the available empirical evidence on provision and production choices and related costs in firefighting services. In the fourth section we discuss the reform of firefighting services in Galicia, and in the next we present the variables, data and methodology of our empirical strategy. The sixth section displays the results from our estimations, which we subsequently discuss. Finally, we draw the main conclusions from our analysis.

Theoretical background to local public service privatization, cooperation and costs

Distinguishing between provision and production of public services is key to analyse reforms in public services management. As stated by Ostrom, Tiebout and Warren (1961:834), "The production of goods and services needs to be distinguished from their provision at public

expense. Government provision need not involve public production...So, a public agency by contractual arrangements with private firms -or with other public agencies- can provide the local community with public services without going into the business of producing them itself." Stiglitz (2000) further elaborates on such distinction providing more precision to those concepts and their applications. Drawing on that differentiation we next elaborate on local public services reforms.

In recent decades local governments have implemented reforms in the production of public services, such as privatization, as a means to achieving a variety of objectives (Bel and Fageda, 2007): fiscal, economic, political, quality-related, etc. Furthermore, local communities may prefer pure market provision (via private contracts) of public services if this better reflects their views on the government's role in the economy, even if such service production proves costlier (Dubin and Navarro, 1988).

An alternative tool for reform that has gained increasing appeal among policy makers and scholars is Intermunicipal Cooperation (IMC), as it has the potential to facilitate the exploitation of scale economies, thus lowering production costs while retaining greater control over production than in the case of privatization (Bel and Costas, 2006; Levin and Tadelis, 2010; Hefetz and Warner, 2012). We are aware that concerns other than costs savings can stimulate cooperation, most notably service stability, equity, and universality (Zeemering 2016; Aldag and Warner, 2018; Warner, Aldag and Kim, 2020). In this study, however, we emphasize the collaborative efficiency rationale for cooperation (Elston, MacCarthaigh and Verhoest, 2018; Zeemering, 2019; Elston and Dixon, 2020), as our empirical analysis is associated with the relationship between provision and production choices and costs.

Privatization of local public services production: Theories and theoretical expectations.

Securing cost savings was one of the main drivers of the privatization policies during the last

decades (Bel and Fageda, 2007). The expectation that cost savings will be achieved through privatization is rooted in two streams of economic theory.

Public Choice: Public choice theory is grounded in the idea of the self-serving interests of policy makers and bureaucrats, following seminal works by Buchanan and Tullock (1962), and Stigler (1971); politicians' and bureaucrats' self-interest leads to budget maximization and excessive supply of public services. Therefore, opening service production to competition and to private production can contribute to reducing oversupply and making public services more efficient and less costly (Niskanen, 1971; Shleifer and Vishny, 1997).

Property Rights: The theory of property rights emphasizes the incentives that exist for private owners (Boycko, Shleifer and Vishny, 1996), who can benefit from the effort they put into reducing costs (Hart, Shleifer and Vishny, 1997). These authors warn, however, that lowering quality as a way of reducing costs can be attractive to private managers because it is not them but the government who gets the blame for quality deterioration. Hence, Levin and Tadelis (2010) suggest that local governments should refrain from contracting out to private firms when they care primarily about the quality of the service.

Both theories (particularly public choice theory), place great confidence in competitive markets. However, public services often have the attributes of quasi-markets (Boyne, 1998a, 1998b; Lowery, 1998), in which market failures are frequent. Two additional streams of theory -transaction costs and industrial organization- give more attention to market failures related to service characteristics, the contracting process and market structure. Both approaches give a primary role to agency theory and its main feature, principal-agent duality.

Transaction costs. Transaction costs theory emphasizes the costs involved in contracting out production of a service and monitoring the performance of the external producer (Williamson, 1979, 1999). Transaction costs have been found relevant in many local public services, related

either to asset specificity or to ease of measurement of service outcomes (Brown and Potoski, 2003a, 2003b), and more generally, with respect to the difficulty of managing contracts (Hefetz and Warner, 2012). Because our study focuses on fire services, it is worth mentioning that this service shows a medium-high level of asset specificity, and a very high level of contract difficulty, according to the rankings of indicators of transactions costs proposed by Brown and Potoski (2005) and Hefetz and Warner (2012). Hence, transaction costs can be an obstacle to achieving cost savings from privatization.

Market structure and competition: Issues related to market structure are the primary focus of the industrial organization approach (Kay and Thompson, 1986; Vickers and Yarrow, 1998). First, the nature of economies of scale that apply to the service is an important factor as it may allow the exploitation of scale by means of aggregating services in different municipalities, and contracting to a private firm can be used to achieve a better scale of operations (Donahue, 1989). Second, the degree of potential competition is a relevant factor in obtaining truly competitive tendering processes, by means of which cost savings could be obtained. However, potential competition depends on the market structure of the sector (Kay and Thompson, 1986). Also, relevant spatial (e.g., rural-urban) differences will affect the availability of private firms (Warner and Hefetz, 2002, 2003). Note, in this regard, that in the ranking suggested by Hefetz and Warner (2012) for potential competition in different local services - based on the number of available vendors- fire services are among those with lower potential, given the very small number of private firms available.

Theoretical expectations: While different, the above theoretical streams are by no means incompatible. They differ in the emphasis that each one places on competition, ownership and transaction costs as determinants of the relationship between private production and costs. In this article we study fire services, which are characterized by high relevance of quality (Levin and Tadelis, 2010), but are difficult to measure. Asset specificity in this service is between

medium and high, and contract difficulty is very high (Brown and Potoski, 2005; Hefetz and Warner, 2012), which implies that private production involves high transaction costs. Furthermore, the availability of private firms tends to be low (Hefetz and Warner, 2012); hence, potential for competition is low. All this considered, we formulate our first hypothesis as follows:

H1: Private production is not associated with lower costs in fire services.

Cooperation in local public services provision: Theories and theoretical expectations.

As stated above, collaborative agreements may seek a wide range of objectives, such as service quality and service stability, equity, and universality (Zeemering 2016; Aldag and Warner, 2018; Warner, Aldag and Kim, 2020). In this subsection we emphasize issues related to costs because this is the focus of the empirical analyses that conduct later. Like Bel and Warner (2015) and Bel and Sebő (2021), we classify the theoretical links between cooperation and costs into three groups: scale-related costs; service-related transaction costs, and organizational transactions costs.

Scale economies: Suboptimal size of municipalities can prevent the realization of economies of scale and the internalization of spill-over effects (Mirrlees, 1972; Dixit, 1973), which may be particularly relevant in the provision of local public services. Ladd (1992) found that higher population reduces production costs, because it makes it possible to benefit from scale economies, at least until scale economies are exhausted as size increases. Ostrom, Tiebout, and Warren (1961) suggested intermunicipal cooperation for public service production as a way to deal with the problem of suboptimal size. In this way, collaborative efficiency is a rationale for cooperation when agreements are driven by the objective of securing scale economies (Elston, MacCarthaigh and Verhoest, 2018; Zeemering, 2019).

Intermunicipal cooperation can be more beneficial for smaller municipalities, as these suffer

most acutely from suboptimal size. However, the potential effects of cooperation likely differ across public services, because the optimal scale is different for each one. Furthermore, intermunicipal cooperation provides municipalities with an alternative to privatization for expanding the scale of operation to those municipalities that want to retain public production (Bel and Costas, 2006; Hefetz, Warner and Vigoda-Gadot, 2012), or have fewer private providers available and, hence, more limited opportunities for competition should they opt to contract to a private firm (Warner and Hefetz, 2002, 2003; Mohr, Deller, and Halstead, 2010).

Service-related transaction costs: Service-related transaction costs consider the specific characteristics of each service (crucially, asset specificity and contract management difficulty). As stated, public services in which transaction costs are higher are less likely to be privatized because their own self-interest leads agents not to cooperate (Jensen and Meckling, 1976). According to Brown and Potoski (2005), this may change when collaboration is based on mutual commitment and trust between participants, which may be more likely under intermunicipal cooperation. When services are exposed to a high risk of opportunism, governments tend to trust other local public agents better than private agents (Brown, 2008), because governments have similar goals. Thus, transaction costs can be lowered. Furthermore, Girth et al. (2012) emphasize that for those services that have available low levels of potential competition, privatization will impose more effort and cost than intermunicipal cooperation regarding the effective monitoring and supervision of the service.

Organizational transactions costs: Organizational transaction costs refer to the governance of the cooperative arrangement for the provision of the service. Feiock (2007) argues that the organizational costs entailed by intermunicipal cooperation can be important, because municipal governments will need to incur in a variety of costs: information, coordination, negotiation, enforcement and monitoring costs. Marvel and Marvel (2007) emphasize monitoring as a relevant problem if services are provided internally by another government

body. Problems related to coordination have been stressed by Lowery (2000) and Tavares and Feiock (2018), and Casulla (2020) discusses how regional governance bodies can play a key role in reducing contractual risks and information barriers for municipal actors. Political transaction costs are discussed in Rodrigues, Tavares, and Araújo (2012) and Bergholz and Bischoff (2018).

Drawing on principal-agent theory, Voorn, Van Genugten and Van Thiel (2019) pay special attention to the frequent existence of multiple principals in intermunicipal cooperation. The existence of multiple principals raises the problem that monitoring can be lower than the level required to guarantee the principals' joint interests, even if they have interests in common (Gailmard, 2009). Therefore, the institutional structure of the body governing the collaboration plays a crucial role regarding monitoring and accountability. Because of this, Voorn, Van Genugten, and Van Thiel (2019) suggest that delegation can reduce transaction costs with respect to other forms of governance, because it implies that the relation is between a principal and an agent. Bel and Sebő (2021) have empirically found that delegation of power and resources to a supra-municipal government can help to reduce costs of service production under intermunicipal cooperation.

Theoretical expectations: Production of fire services requires specific facilities and specialized vehicles, which implies some degree of fixed investments. Therefore, some scale economies can be expected in this service. However, they might be of limited relevance with respect to population covered, although increasing returns to scale regarding quality are important (Duncombe and Yinger, 1993). Given the service characteristics, asset specificity and contract difficulty imply high service-related transaction costs, which may be attenuated by means of intermunicipal cooperation (Brown and Potoski, 2005; Hefetz and Warner, 2012). Whether organizational-related transactions will outweigh potential benefits from scale economies and reduced transactions costs may depend on the type of governance of the collaboration (Voorn,

Van Genugten and Van Theil, 2019). Hence, we formulate our second hypothesis as follows:

H2: Cooperation for the fire service provision is associated with lower costs.

With respect to alternative choices of service production under cooperative provision, we formulate two additional hypotheses:

H3: Under cooperative provision, either public or private production is less costly than stand-alone municipal provision.

H4: Under cooperative provision, no significant differences in costs exist between public and private production.

Empirical evidence on provision and production choices and costs in local fire services

Private production of fire services and costs

While empirical evidence on the relationship between private production and costs is abundant for many local services such as solid waste collection, water distribution or bus transport, evidence from privatized fire services is extremely scarce and mostly anecdotal. Ahlbrandt (1973) provides perhaps the most robust preliminary technical analysis of fire service costs that also discusses privatization. He empirically estimates the cost drivers of different types of public production organizational arrangements for fire services in Seattle-King County (Washington State, US). Then, based on the results of his multivariate estimation on actual public units, Ahlbrandt constructs a counterfactual of costs for a potential publicly managed unit in the city of Scottsdale (Arizona), where the fire service was actually under private production. He concludes that the public counterfactual would operate less efficiently than the actual private firm.

Graham et al. (1992) conducted a comparative study of fire services in the United Kingdom,

Denmark, the Netherlands and Sweden. They found that expenditure (related to GDP) on fire services was lower in Denmark than the other three countries (p. 21, Table 1). While the authors discuss the particular role of the private company Falck in Denmark, with no relevant private production existing in Britain, The Netherlands or Sweden, no specific conclusion on the potential association of private operation with the lower relative costs in Denmark is possible, because the data used do not allow for a robust explanatory analysis.

As mentioned, only one multivariate analysis for fire service privatization and costs has been published: that by Kristensen (1983) for Denmark. This study conducts an econometric estimation for the cost of fire services by distinguishing between public and private production, the latter being operated by the company, Falck, a firm that has existed since 1926 and currently serves around half the population of Denmark. Results obtained indicate that private production is less costly than municipal public production. Kristensen argues that Falck's cost advantage is based on its greater ability to exploit scale economies, and to engage in joint provision with other services (e.g. civil defence), thus exploiting scope economies. Furthermore, he suggests that Falck is subject to the threat of municipalization if performance is poor, which introduced a competitive pressure on the firm.

Intermunicipal cooperation in fire services and costs

The effect of inter-municipal cooperation on efficiency and costs has recently been studied by Holmgren and Weinholt (2016) in Sweden, by Blåka (2017a) in Norway, and by Aldag, Warner and Bel (2020) in the US. Holmgren and Weinholt (2016) use stochastic frontier analysis with a sample of Swedish municipalities to study, among other issues, whether IMC affects efficiency in fire services, and they find that cooperation is actually associated with lower efficiency of the service. In turn, Blåka (2017a) employs parametric estimation techniques on a sample of Norwegian municipalities, with the main objective of analysing the effect of IMC

on costs. She finds that costs of fire and rescue services are lower with IMC under contractual agreements; however, cost savings significantly decrease when the number of municipalities participating in the cooperation increases. Finally, using a simpler model similar for 12 local services, Aldag, Warner and Bel (2020) do not find any significant association between cooperation and costs in the state of New York. All these studies suggest that transaction cost caused by joint governance of services can compensate -even outweigh- the potential benefits achievable from scale optimization.

While none of these three studies include private production of fire services in their analysis, the empirical modelling in Holmgren and Weinholt (2016) and Blåka (2017a) is the most robust in the literature so far. Thus, they will be very useful later in this study when we design the modelling for our own empirical analysis. Our study contributes to the literature by providing the second multivariate analysis to date (after Kristensen, 1983) on the relationship between private production of fire services and costs. Beyond the scope of Kristensen (1983), we have available a dataset for different years, which allows us to use more robust econometric techniques. Moreover, given the inter-municipal cooperation and provincialisation of fire services in the jurisdiction of our study (Galicia, Spain), and the legal compatibility of all provision forms with both public and private production in Spain (unlike the Scandinavian countries), we can analyse the effect of private production on costs, taking into account whether the service is provided by stand-alone municipalities or by entities that integrate several municipalities.

The Galician Case: Cooperation, Integration, Public and Private Fire Services

In the region of Galicia a special formula for the provision and production of urban firefighting services has been developed over the last two decades. This model mixes public and private

production with provision by stand-alone municipalities or by inter-municipal cooperation (be it at county level or at provincial level).

The country-wide legal framework for local public services in Spain was established in Law 7/1985, Local Regime. Regarding firefighting, municipalities with populations above 20,000 are obligated to provide the service. Due to its demographic and geographic characteristics (many sparsely populated areas, as well as high dispersion of municipalities, i.e., 313 in a 29.575 km^2 area), the region of Galicia did not enjoy adequate service coverage, either in terms of efficiency, effectiveness or quality. Back in 1985, only 19 of the Galician municipalities reached the 20,000 inhabitants' threshold. Moreover, only the seven largest of those 19 municipalities provided fire services. In all seven cases, the fire services were delivered by means of public units.

Given the lack of further development of fire services in the years following, about a decade later, the regional government (Xunta de Galicia) passed Law 5/1997, intended to promote expansion of coverage and modernization of the fire services in the region. To do this, the law planned for the creation of a network of modern fire stations and related infrastructures (focusing mainly on rural areas). Aware that most municipalities would not be able to fulfil the regulatory requirements by themselves, the law allowed for inter-municipal cooperation by enabling the creation of voluntary joint organizations (*consorcios*), consortia which could decide how the production of municipal services is organized when municipalities delegated provision to them. Municipalities, together with provincial and regional governments, shared the costs of coordination between all the jurisdictions involved.

These collaborative units were established at county level, the first being the *Consorcio de Bomberos de Deza y Tabeirós-Terra de Montes* in 1999, a supra-municipal entity which built a fire station to provide fire services in both rural counties, Deza and Tabeirós-Terra de Montes, by means of in-house resources. By the early 2000s, there were nine fire stations in Galicia,

covering 39.35% of the population and 10.88% of the region's surface area. Seven of these corresponded to the seven largest cities and were already in service by 1985; another was created at municipal level in Ponteareas, with a small fire station, a large volunteer contingent and non-professional management (this one would be transformed in 2016 into an inter-municipal cooperative organization, covering several other municipalities and using public production), and the last one corresponded to the above-mentioned consortium of Deza and Tabeirós-Terra de Montes.

In the early 2000s, a change in the production model began to be implemented. The *Consorcio de Bomberos de Valdeorras* was created to provide fire services in the county of Valdeorras with a newly built fire station. However, unlike the previous case of Deza and Tabeirós-Terra de Montes, production of the service was awarded to a private company (Veicar S.L.; *Vehículos, Equipamiento y Carrocerías Prieto-Puga*) for the first time in the region. In this model of provision, buildings and infrastructure are publicly owned, and a private company produces the service. The regional government kept on promoting this private production model in the following years, signing agreements with municipalities and provincial governments. By means of these agreements, all relevant governments would cooperate to build fire stations, and service production would be awarded to private firms. Between 2000 and 2007, 13 such fire stations were built.

While left-wing parties in the regional opposition initially rejected the privatization process, the model was sustained over time. In fact, in 2007 (with a left-wing coalition now in the regional government), Law 5/2007 (Emergencies Law) was passed. This law transferred responsibility for the provision of fire services in municipalities with less than 20,000 inhabitants or more than 20,000 inhabitants but without their own fire services, from county consortia to four provincial organizations called *Consorcios Provinciales Contraincendios y Salvamento* (Provincial Consortia for Fire Protection and Rescue).

All municipalities meeting the legal requirements were compulsorily assigned to their corresponding provincial consortium in which the provincial (*Diputación*) and regional (*Xunta de Galicia*) governments also participated in order to fund infrastructure and equipment. County-level cooperative units were suppressed in favour of supra-municipal bodies organized at province level and dependent on the provincial government (still local, but a higher tier of government). The only exceptions to the reform were the eight municipalities (the seven largest ones plus Ponteareas) and the county consortium (Deza and Tabeirós-Terra de Montes) that were already in operation prior to 2000.

The four active provincial consortia are responsible for defining the areas of priority intervention for each privately managed fire station, in order to guarantee, as far as possible, minimal and equitable intervention times throughout the territory. In the face of exceptional emergencies, all the fire brigades can extend their priority area, receiving compensation for extra costs thus incurred. Since 2007, 11 additional fire stations have been built and production of the service has been awarded to private firms. Together with the previously existing fire stations, they form the current distribution of local fire services in the region, which is represented in Figure 1.

(insert Figure 1)

By 2018, the four provincial consortia were managing twenty-four fire stations, located mostly in rural areas, all of them under private production regimes. These fire stations covered 43.55% of the Galician population and 60.65% of the surface area. Furthermore, the consortia of Deza and Tabeirós-Terra de Montes and Ponteareas are inter-municipal collaborations at county level, both of them with public production regime, covering 4.49% of the population and 7.56% of the surface area. Finally, in the seven largest municipalities (Vigo, Pontevedra, Ourense, Lugo, A Coruña, Santiago de Compostela and Ferrol) the urban fire service is under municipal

control with in-house production in all cases, covering 36.57% of the population and 3.32% of the surface area.

Table A-1 in the appendix shows current (2018) coverage of population and surface area by the fire services in the region. Table 1 displays information on provision, production and the public and private organizations that produce the fire services.

(Insert table 1)

Data, Variables and Empirical Strategy

Data and sources

The database for this analysis contains information on 13 observation units, which comprise all the service areas of urban fire services in Galicia. As mentioned, fire services focused on industrial facilities or forest brigades are outside the scope of this work. Setting up the sample and building the dataset involved several steps. Data collection began in March 2018, and the starting point was to collect all the information about population and surface area of the municipalities in Galicia from the official statistics of the Spanish Statistical Institute (*Instituto Nacional de Estadística,* INE https://www.ine.es/dyngs/INEbase/es/categoria.htm?c=Estadistica_P&cid=1254734710990).

The next step involved searching for data on costs of the fire service in all public transparency websites of the municipalities and county/provincial consortia that provide the service (see, for instance, that of the provincial consortium of A Coruña, https://www.depo.gal/es/informacion-economica-e-financeira/consorcio-provincial-de-bombeiros). Also, information on tenders in those cases where the service was awarded to private firms was obtained from transparency websites. Furthermore, direct requests for information were sent to the corresponding governments when data were lacking in the transparency websites. Finally, we contacted the

Galician Emergency Service-telephone 112 (https://www.axega112.gal/es), who provided us with data on interventions. The data collection process finished in December 2019.

The time range for the empirical analysis is 2010-2018. Two main factors justify the choice of 2010 as the initial year. On the one hand, by the end of 2000 the construction of new fire stations had begun, and production of the service was awarded to private firms. The initial term of the contracts used to be eight years, and contract renewals had begun to occur regularly by early 2010. From that moment on, the number of private fire stations in operation was large enough to allow statistical analysis of data. Furthermore, after Law 30/2007 was passed, data transparency and the granting of public access to information concerning public contracts were enhanced. From then on, data on costs and other relevant variables in our analysis had to be made publicly available. We must recall, however, that information on service costs is not available for all years in all observation units. Furthermore, there are fire stations that started their activity in some intermediate year of the period under analysis (e.g. Carballiño in 2016).

Variables

The key (dependent) variable in our empirical analysis is the annual operating *cost* of the fire service for each observation unit. That is, the costs paid for by governments for the operation of the service (as facilities and vehicles are provided by the governments in all cases). The variable is expressed in nominal values (€), for each year and observation unit. We include a set of explanatory variables, defined as follows:

Population: Demographic conditions of the municipalities covered by each service area affect fire service costs, so the population in the intervention area of each observation unit is considered. Although municipalities in Galicia vary in population, the fact that service in the smaller and medium-sized municipalities is jointly provided allows exploitation of economies

of scale. We take population logs, as in Blåka (2017a), and expect a positive relationship between population and costs.

Surface area of intervention (square kilometres), *density of population* (inhabitants per square kilometre), and *operational unit dimension* (inhabitants per each fire station in a service area): These three variables may affect service costs because regulatory requirements tend to specify compulsory response times that fire units must meet. A large surface area of intervention and high density of population imply that more fire services must be distributed in a jurisdiction (Blåka, 2017a). Furthermore, fire services are subject to congestion costs (Brueckner, 1981), which might be captured by the dimension of the operational unit.

Interventions: Level of workload is expected to influence the costs of the service. We measure the workload by the number of interventions (when a truck leaves the station to put out a fire or carry out prevention tasks). We expect a positive relationship between workload and costs of the service.

Regarding the organizational explanatory variables, we decompose them in a way that all four hypotheses formulated above can be analysed:

Production form: The variable *private* indicates service areas with private production. The variable *public* indicates service areas with public production. These are our key explanatory variables to check H1, as they address the question of whether costs under private production are different from those under public production. According to H1, we expect not to find a significant association between private production and costs. Available evidence on private production of public services and costs is mixed, and no systematic savings are found (Bel, Fageda and Warner, 2010; Overman, 2016). However, the only multivariate empirical analysis for fire services of which we are aware, that by Kristensen (1983), found lower costs with private production in Denmark.

Provision*:* Whether the service is provided by a stand-alone municipality (*municipal*) or by a cooperative organization (*cooperation*) might influence costs, as stated in H2 above, based on which we expect to find that cooperation reduces costs. Most studies on inter-municipal cooperation and costs conducted in Spain have found cost savings with cooperation (Bel and Sebő, 2021; see also Silvestre. Marques and Gomes, 2018). However, regarding fire services, the evidence is more mixed. Holmgren and Weinholt (2016) found lower efficiency with cooperation in Sweden, Blåka (2017a) found lower costs with contractual inter-municipal cooperation in Norway, and Aldag, Warner, and Bel (2020) did not find any significant association in the US.

Interaction between provision and production: *Cooperation*Public* indicates public production under cooperation, including all collaborations that use public production; all collaborations that use private production are grouped in the variable *Cooperation*Private* (recall that his variable has the same composition as *private*) Therefore, singling out cooperation either with public or with private production allows us to disentangle the effect of production form from that of provision choice. Finally, the variable *Municipal*Public* indicates municipal stand-alone provision with public production (recall that his variable has the same composition as *municipal*). In this way we can first check H3 (stand-alone provision versus each type of cooperation) and H4 (cooperation with private production versus cooperation with public production). Recall that in our context *Private* is equivalent to cooperation with private production, as all consortia at provincial level have private production, and none of the stand-alone municipalities uses private production. As far as we know, there is no previous evidence for our hypotheses H3 and H4.

Figure 2 shows how the organizational variables are structured. Table 2 displays the descriptive statistics for all variables.

(Insert Figure 2 here)

(Insert table 2)

Methodology

Following the standard approach presented in the background section, the dependent variable of the model is that of costs. In that regard, it is important to note that fire stations as well as vehicles are provided in all cases by the corresponding governments, which implies that only variable costs are potentially related to the type of production of fire services. Therefore, our variable measures the total operating costs for fire services (measured as annual operational expenses for the service for each fire station). The equations that we estimate are:

$$Cost_{it} = \beta_0 + \beta_1 Population_{it} + \beta_2 Surface_{it} + \beta_3 Density_{it} + \beta_4 OpUnitDimension_{it} + \beta_5 Interventions_{it} + \beta_6 Private_{it} + \varepsilon_{it} \quad (1)$$

$$Cost_{it} = \beta_0 + \beta_1 Population_{it} + \beta_2 Surface_{it} + \beta_3 Density_{it} + \beta_4 OpUnitDimension_{it} + \beta_5 Interventions_{it} + \beta_6 Cooperation_{it} + \varepsilon_{it} \quad (2)$$

$$Cost_{it} = \beta_0 + \beta_1 Population_{it} + \beta_2 Surface_{it} + \beta_3 Density_{it} + \beta_4 OpUnitDimension_{it} + \beta_5 Interventions_{it} + \beta_6 Cooperation*Private_{it} + \beta_7 Cooperation*Public_{it} + \varepsilon_{it} \quad (3)$$

$$Cost_{it} = \beta_0 + \beta_1 Population_{it} + \beta_2 Surface_{it} + \beta_3 Density_{it} + \beta_4 OpUnitDimension_{it} + \beta_5 Interventions_{it} + \beta_6 Municipal*Public_{it} + \beta_7 Cooperation*Public_{it} + \varepsilon_{it} \quad (4)$$

where sub-indices *i* and *t* represent service area and year, respectively. All variables have been described above (and descriptive statistics have been provided in table 2), and ε is a heteroscedasticity-robust error term.

In equation (1) the key variable for our study is *Private,* a dummy that takes value 1 when the service is delivered by a private firm, and 0 otherwise (*public* is used as reference category). In equation (2) our key organizational variable is *Cooperation*, a dummy variable that takes value 1 when the service is provided jointly in several municipalities, and 0 when it is provided by a

stand-alone municipality (*municipal* is used as reference category). In equation (3) the key organizational variables are *Cooperation*Private* (=*private* in (1)), and *Cooperation*Public*, a dummy variable that takes value 1 when the service is jointly provided and uses public production, and 0 otherwise (*Municipal*Public* is used as reference category). Finally, in equation (4) the key organizational variables are *Municipal*Public* (=*municipal* in (2 and 3)), and *Cooperation*Public* as in (3), and 0 otherwise (*Cooperation*Private* is used as reference category).The remaining variables are demographic or geographic (*population, surface, density, and OpUnitDimension*), and *interventions*, taken as a measure of output.

A relevant methodological point that is worth discussing is that of potential endogeneity between costs and the decision to privatize the service; more particularly, whether the choice of awarding concessions to private firms can be due to prevailing cost conditions of the service. In our case, we can recall that the policy of awarding private concessions was implemented in all cases after the legal reforms initiated in 2000 by the regional government, and it has not been applied to those pre-existing services already in operation before 2000. Hence, we believe that potential endogeneity between production type and costs is not a relevant issue in our study.

Turning now to statistical issues, we conduct robust estimations to control for heteroskedasticity. The average Variance Inflation Factor (VIF) is 5.90, 4.14, and 5.40 respectively, and all single variables have an individual VIF below 10. Given the panel nature of our database, we ran the Hausman test, which yielded p=0.141, p=0.150 and p=0.157 respectively, indicating that random-effects estimations are more appropriate. The Breusch and Pagan's LM tests for random effects indicate that GLS estimations are preferred to OLS.

Results

Table 3 shows the results obtained from the random-effects GLS estimation. For equations (1),

(2), (3) and (4). From this set of estimations, and within the domain of variables related to service production, we can first observe in model (1) that our key explanatory variable, *private*, does not show a significant influence on costs. Hence, consistent with H1, we cannot reject the possibility that there is no significant difference between private and public production in terms of their influence on the cost of fire services in our area of study. In this regard, our results are different than those obtained by Kristensen (1983) in Denmark.

(Insert table 3)

Regarding service provision, in model (2) our variable *Cooperation*, which represents cooperative provision of fire services, appears associated with lower costs for the service, as the coefficient is negative and highly significant, which is consistent with H2. Our results are similar to those obtained by Blåka (2017a) in Norway, and opposite to those in Holmgren and Weinholt (2016) for Sweden. Note, however, that -like Blåka (2017a)- we analyse costs incurred for the service, while Holmgren and Weinholt (2016) analyse technical efficiency.

In Model (3), form of provision and form of production are considered jointly, and we can compare stand-alone provision with both cooperation with public production and cooperation with private production. Our results indicate that cooperative provision with public production has significantly lower costs than stand-alone provision with public production ($p=0.029$). However, cooperative provision with private production does not show a significant cost difference with respect to municipal provision with public production ($p=0.108$). In this way, we obtain mixed results for our H3.

In Model (4) we repeated the estimations of equation (3) but replacing *Cooperation*Private* with *Municipal*Public*, so that we can additionally analyse the comparison between different production forms (public and private), when provision is cooperative (*Cooperation*Public* versus *Cooperation*Private*). We find no difference in costs between public and private

production when both occur under cooperative provision (p=0.637), consistent with H4. Obviously, for *Municipal*Public* versus *Cooperation*Private* we obtain the same result as in model (3), but with the sign inverted.

As a robustness check, we have estimated all models with pooled cluster robust OLS, and the results are identical in sign and significance (results available upon request).

Finally, demographic and geographic variables operate as expected in the case of *population* and *surface* and *OpUnitDimension*. In all three cases, these variables have a significant positive association with costs across most estimations, when not all. Instead, we find *density* significant only in model 3, but it is not in models 1 and 2. Furthermore, the number of interventions shows a positive and significant association with costs, as expected.

Discussion

By the early 2000s, the government of Galicia was promoting the expansion of the fire service by means of collaborative units that integrated several municipalities and awarding the production of the service to private firms. Our results suggest that while cooperative provision seems to have been an appropriate strategy for expanding the coverage to less populated areas, production by private firms does not have a significant effect on the costs incurred, as compared to previously (and still) existing fire stations under public production.

More specifically, regarding the result for private production, we have found that private production does not have significant cost difference with respect to public production (consistent with our H1). This result holds when we distinguish public production according to the form of provision, and compare private production with public production under stand-alone provision on the one hand, and with public production under cooperative provision on the other. Our results are different from those obtained by Kristensen (1983) for Denmark. A

notable dissimilarity between the analyses is that, unlike Kristensen, in our case we consider the type of provision (whether cooperative or stand-alone). Furthermore, all private production cases in our sample operate under cooperative provision, whereas in Kristensen (1983) private production operated under stand-alone municipal provision.

The lack of cost savings with private production may be associated with a lack of significant competition for the contracts. The regional market for private fire services has a small number of private firms available, and is strongly dominated by Veicar S.L., the first private firm to enter the regional market: this firm manages fourteen out of the twenty-four privately managed fire stations and holds dominant positions in three out of the four provincial consortia. Furthermore, cooperative strategies have been developed by Veicar S.L. and Natutecnia S.L., the second firm in the regional market, which manages six out of the ten remaining fire stations that have been awarded to private firms. In fact, Veicar S.L. and Natutecnia S.L. presented a joint bid for the 10 fire stations in the A Coruña consortium tender process developed in 2014, and were awarded them all. This tendering process was declared null and void by the courts, and the pre-tender distribution of concessions of fire stations in the province was continued and is still in place (as can be seen Table 1 above). Notwithstanding the nullity of the tender, as declared by the courts, this process made clear the marginal scope for competition for contracts in the regional market for fire services.

Further to competition failures, it is worth recalling that incomplete contracts and quality measurement are more problematic in fire services than in other services such as waste collection. Recall that fire services are ranked as having a medium-high level asset specificity and a high level of contract difficulty in both rankings of indicators of transactions costs, as proposed by Brown and Potoski (2005), and Hefetz and Warner (2012). Therefore, achieving cost savings through private production of fire services can be limited by transaction costs.

Unlike private production, cooperative provision is associated -overall- with lower costs than

stand-alone municipal provision, consistent with H2. This result is mainly driven by the combination of cooperative provision and public production (consistent with H3). As mentioned, we did not find a significant cost difference between private production under cooperative provision and public production under stand-alone municipal provision. Nonetheless, we did not find cost differences between production forms under cooperative provision either (consistent with H4).

Our results showing cost savings with cooperation are consistent with those by in Blåka (2017a) for Norway, but contrary to those in Holmgren and Weinholt (2016) for Sweden. Recall, however, that our dependent variable is costs paid for the service, as in Blåka, whereas Holmgren and Weinholt use indicators of technical efficiency. Even if scale economies are of limited degree in fire services, the low population of many Galician municipalities can favour benefiting from them with cooperation. In 2018, average municipal population in the region was 8,632 inhabitants. This is much lower than in the two other countries for which cooperation and costs have been empirically analysed: In 2018, Norway's average municipal population was almost double (14,999 inhabitants), and Sweden's (44,897 inhabitants) more than five times that of Galicia. Hence, there was more opportunity for exploiting scale economies in fire services by means of cooperation in Galicia than in Norway and (especially) Sweden.

Second, the governance of cooperation in Galician fire services is not conducted by means of joint boards of the municipalities involved (as it is in Norway and Sweden), but is delegated to another tier of local government. Voorn, Van Genugten and Van Theil (2019) have suggested that this type of delegation reduces the multiple principal problem encountered in cooperative provision, and Bel and Sebő (2021) have found it to be empirically associated with lower costs.

Our study has some limitations. First, we do not have a good enough measure of quality for fire service interventions. Second, the dependent variable (operating costs) does not include transaction costs incurred by the government that contracts out the service (which introduces a

slight downward bias of costs of services privately produced). Third, because the region does not have any case of private production in stand-alone municipalities, we could not compare public and private costs under municipal provision. These limitations notwithstanding, we believe that the results we have obtained provide relevant policy considerations. First, inter-municipal cooperation can be an adequate way to expand coverage of fire services to sparsely populated areas. Second, privatization of production of fire services might not yield significant cost savings. Competition failures and high transaction costs of contracting out fire services can be a severe limiting factor in that regard.

Conclusion

This article has analysed the reform undertaken in fire services in the Spanish region of Galicia, where, in the last two decades, inter-municipal cooperation and private production have been widely used to expand fire protection to sparsely populated areas that were not previously covered. Within this context, we have empirically analysed how private production relates to the cost of services, and whether cooperation delivers cost savings, by means of a database for the period 2010-2018 covering all the existing intervention areas in the region.

The results we have obtained suggest that cooperation is an efficient tool for expanding the service. However, we do not find any significant relationship between production type (private or public) and costs incurred for fire service. Competition failures and high transaction costs can be relevant obstacles to improving cost conditions with privatization in this service.

Our findings have practical relevance for policymakers, because some clear policy implications emerge. Cooperation can be a useful tool for service stability, equity and universality, without undermining cost-efficiency in the production of the service. In fact, costs savings can be obtained; particularly, when scale economies can be realized, and when the design of the collaborative governance helps to avoid incurring in high transaction costs. The implications

that we derive from our research can extend beyond fire services; they may apply as well to other public services with relevant asset specificity and very high contract management difficulty. These services are, precisely, the ones for which privatization seems to be more problematic when used as a tool for local government reform.

Data limitations have prevented us from considering quality in our study. Future research could benefit greatly from obtaining more refined data on nature and intensity of fire stations interventions. Having available quality indicators would also be instructive so that analysis of the relationship between provision arrangements, production form and outcomes could be enhanced and improved.

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Table 1. provision, production form and organizations that manage fire services in Galicia

Province	Entity	Provision	Production	Operator	# Fire Stations
A Coruña	A Coruña	Municipal	Public	S. de Compostela Municipality	1
A Coruña	Ferrol	Municipal	Public	A Coruña Municipality	1
A Coruña	S. Compostela	Municipal	Public	Ferrol Municipality	1
A Coruña	A Coruña-Consortium	Cooperation-P	Private	VEICAR SL	7
				NATUTECNIA SL	3
Lugo	Lugo	Municipal	Public	Lugo Municipality	1
Lugo	Lugo-Consortium	Cooperation-P	Private	VEICAR SL	3
				UTE HASA-NATUTECNIA SL	3
Ourense	Ourense	Municipal	Public	Ourense Municipality	1
Ourense	Ourense-Consortium	Cooperation-P	Private	VEICAR S.L.	4
Pontevedra	Ponteareas	Cooperation-C	Public	Pontеareas Municipality	1
Pontevedra	Pontevedra	Municipal	Public	Pontevedra Municipality	1
Pontevedra	Vigo	Municipal	Public	Vigo Municipality	1
Pontevedra	Deza-Tabeirós-Consortium	Cooperation-C	Public	Deza-Tabeirós Consortium	1
Pontevedra	Pontevedra-Consortium	Cooperation-P	Private	MATINSA S.A.	4

Note: Cooperation-P: Provincial level. Cooperation-C: County level

Source: Authors.

Table 2. Descriptive Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Cost	4209779	301392	285277	8953794
Population(log)	5.246	0.038	4.711	5.370
Surface (Km^2)	1739	310	37.8	6603.3
Density (hab/km^2)	1503	272	26.2	6511.8
OpUnitDimension	127573	11619	18204	297355
Interventions	1453	199	25	7304
Public	0.692	0.058	0	1
Private	0.308	0.058	0	1
Municipal	0.615	0.061	0	1
Cooperation	0.385	0.061	0	1
*Municipal*Public*	0.615	0.061	0	1
*Cooperation*Public*	0.077	0.033	0	1
*Cooperation*Private*	0.308	0.058	0	1

Note: Recall that *Municipal* and *Municipal*Public* have the same composition, and so do *Private* and *Cooperation*Private.*

Table 3. Results from Random-effects GLS.

Type	Variables	(1) Random Effects	(2) Random Effects	(3) Random Effects	(4) Random Effects
Demo-Geographic	*Population(log)*	3805412** (1689491)	3062507** (1194126)	3214736* (1636769)	3214736* (1636769)
	Surface	577.358*** (214.925)	597.162*** (198.601)	661.968*** (172.488)	661.968*** (172.488)
	Density	-236.528 (158.602)	-105.915 (260.992)	-275.673***** (140.823)	-275.673***** (140.823)
	OpUnitDimension	16.215** (6.469)	13.792 (8.842)	16.971*** (5.697)	16.971*** (5.697)
Output	*Interventions*	208.404** (101.442)	136.537** (52.672)	252.572** (106.987)	252.572** (106.987)
Organizational	*Private*	-1502468 (1404062)			
	Cooperation		-1370239** (624667)		
	*Municipal*Public*				1939730 (1207060)
	*Cooperation*Public*			-1392949** (636649)	546781 (1159343)
	*Cooperation*Private*			-1939730 (1207060)	
	Constant	-1.83 e+07** (7977506)	-1.44 e+07*** (5463205)	-1.51 e+07* (7749358)	-1.51 e+07* (7749358)
	Observations	65	65	65	65
	# Service areas	13	13	13	13
	Time	YES	YES	YES	YES
	R-2 within	0,094	0,117	0.086	0.086
	R-2 between	0.888	0.908	0.916	0.916
	R-2 overall	0.881	0.886	0.898	0.898

Robust standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.10

Notes: Given the nature of Model 4, all results are identical to those in Model 3, with the exception of those for organizational variables.

Reference categories: *Public* in Model 1; *Municipal* in Model 2; *Municipal*Public* in Model 3; *Cooperation*Private* is in Model 4.

Appendix.

Table A-1. Territorial distribution of fire services in Galicia and coverage (population and surface, 2018)

Province	Entity	Municipalities	Inhabitants	Percentage	Surface (km^2)	Percentage
A Coruña	A Coruña-Municipality	1	244.850	9,06%	37,8	0,13%
A Coruña	Ferrol-Municipality	1	66.799	2,47%	82,7	0,28%
A Coruña	S. Compostela-Municipality	1	96.405	3,57%	220	0,74%
A Coruña	A Coruña-Consortium	68	519.795	19,24%	6.093,1	20,60%
A Coruña	**Total A Coruña**		*927.849*	*34,34%*	*6.433,6*	*21,75%*
Lugo	Lugo-Municipality	1	98.025	3,63%	329,8	1,12%
Lugo	Lugo-Consortium	49	200.055	7,40%	6.603,3	22,33%
Lugo	**Total Lugo**		*298.080*	*11,03%*	*6.933,1*	*23,44%*
Ourense	Ourense-Municipality	1	105.505	3,91%	84,6	0,29%
Ourense	Ourense-Consortium	54	139.360	5,16%	4.108,8	13,89%
Ourense	**Total Ourense**		*244.865*	*9,06%*	*4.193,4*	*14,18%*
Pontevedra	Ponteareas-Consortium	8	51.393	1,90%	546,4	1,85%
Pontevedra	Pontevedra-Municipality	1	82.802	3,06%	118,3	0,40%
Pontevedra	Vigo-Municipality	1	293.642	10,87%	109,1	0,37%
Pontevedra	Deza-Tabeirós-Consortium	9	69.990	2,59%	1.690,5	5,72%
Pontevedra	Pontevedra-Consortium	31	317.389	11,75%	1.132,4	3,83%
Pontevedra	**Total Pontevedra**		*815.216*	*30,17%*	*3.596,7*	*12,16%*
Total			**2.286.010**	**84,61%**	**21.156,8**	**71,53%**

Source: Authors, based on data from Instituto Nacional de Estadística, and entities' official web pages.

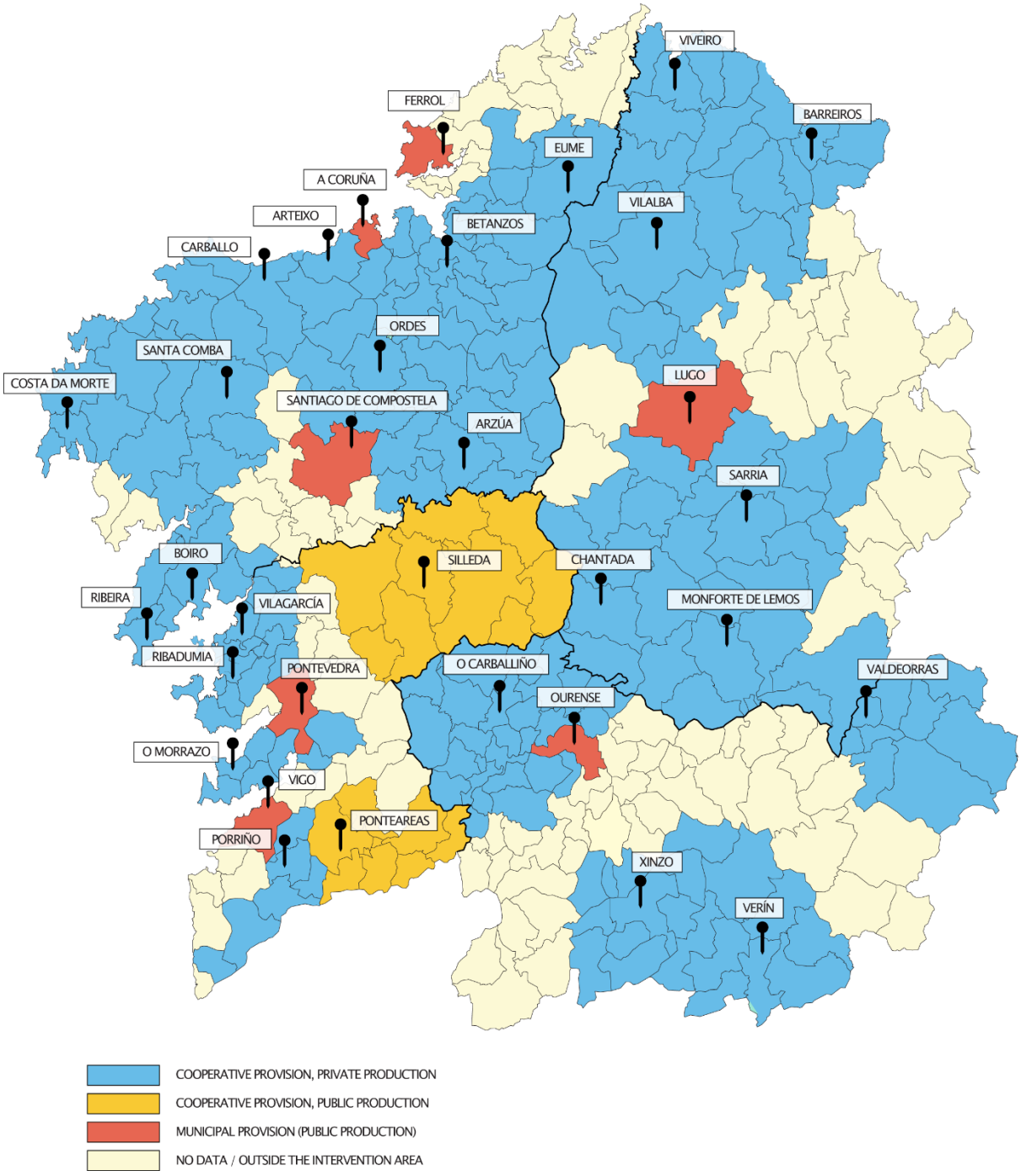

Figure 1: Map with distribution of fire services in Galicia (2018)

		PRODUCTION	
	JURISDICTION/GOVERNMENT	1.-PUBLIC	2.-PRIVATE
PROVISION	A.-Municipal (=Stand-alone)	A1	A2 (=Ø)
	B.- Supra-municipal (=Cooperation)	B1	B2

Note: A2 is an empty category in our sample. Therefore, we have the following sets:
Provision: *Municipal*=A1+A2 (=A1); *Cooperation*=B1+B2
Production: *Public*= A1 + B1; *Private*= A2 + B2 (=B2)
Provision*Production: *Municipal***Public*=A1; *Cooperation***Public*= B1; *Cooperation***Private*=B2.

Figure 2: Organizational variables

Figure Captions

Figure 1: Distribution of fire services in Galicia (2018)

Figure 2: Organizational variables