When the Time is Right: Testing for Dynamic Effects in Collaborative Performance

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Abstract: Organizations collaborate in order to manage external interdependencies that are consequential for performance. Econometric evaluation of collaboration has advanced considerably; but has not, typically, incorporated explanatory variables related to time. Drawing on theories of environmental dynamism, organizational inertia, accountability "drift," and isomorphism, we test whether duration and timing of collaboration in waste collection affect financial performance for 178 municipalities in Catalonia during 2000-2019. We find that cost advantages of this "intermunicipal cooperation" declined over this period, due to reduced interdependence among municipalities. Timing had no effect on financial outcomes; but "early" and "late" collaborators differed in character and policy objectives.

Keywords

Collaborative public management; organization theory; inter-municipal cooperation; inter-organizational relations; local government; shared services

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1. Introduction

Organizations of all kinds – firms, non-profits, and public bodies – develop inter-organizational relationships in order to manage external interdependencies that are consequential for performance (Gray, 1989; Alter & Hage, 1993; Agranoff & McGuire, 2003; Huxham & Vangen, 2005; Bingham & O'Leary, 2014). These interdependencies, which can deeply affect organizational functioning and yet fall beyond direct control of management, relate to the acquisition of scarce and valuable resources (Pfeffer & Salancik, 1978; Malatesta & Smith, 2014), the management of task interconnectivity and negative externalities (Agranoff & McGuire, 2003; Ostrom, 2015), or the generation of scale economies (Elston et al., 2018). By somehow collaborating – be it formally or informally, with one or many partners, and with or without significant resource commitment – the intention is for managers to attain greater influence over these external influences than would otherwise be the case, improving organizational outcomes.

Econometric research has tested whether inter-organizational collaboration results in improved performance among public service providers (Meier & O'Toole, 2003; Andrews & Entwistle, 2010; Lee et al., 2018; Fowler, 2019; see meta-analysis in Lee & Hung, 2021), particularly in regard to productive efficiency (Andrews & Entwistle, 2015; Niaounakis & Blank, 2017; Ferraresi et al., 2018; Park et al., 2018; Elston & Dixon, 2020; Luca & Modrego, 2021; see meta-analyses in Silvestre et al., 2018 and Bel & Sebő, 2021). In line with the precepts of contingency theory, which hold that performance is optimized by "fitting" organizational structure to specific circumstances (Donaldson, 2001; Andrews et al., 2015), financial benefits have been shown to depend on the cost function of the shared activity (i.e., the precise relation between service volumes and marginal costs), the size of the partnering organizations, and the ability to control opportunism among partners (Bel & Sebő, 2021). Yet findings remain somewhat inconsistent across studies, and models often contain unexplained variance, indicating that our theories of collaborative advantage remain incomplete. As Lee and Hung (2021, pp.1-2) recently summarized, "factors affecting … collaboration results remain insufficiently explored and the scant information that is available is inconsistent."

In this paper, we investigate whether greater attention to variables related to *time* – specifically, the *duration* of collaboration, and *timing* of its inception relative to other collaborations – can improve econometric modelling. Scholars of both business management and public administration have called for greater attention to time and temporality in empirical and theoretical research (Hassard, 2002; Whipp et al., 2002; Pollitt, 2008; Howlett & Goetz, 2014). Modern contingency theorists argue for a more "dynamic" conception of fit, in which the matching of contingencies is not "an end-state for the organization to achieve" but "an ongoing process to be continually managed" (Nissen, 2014, p.30; see also Klaas, 2004; Van de Ven et al., 2013). Many attributes of inter-organizational partnerships are already recognized as time-variant, most notably in work on collaboration "life cycles" (Seabright et al., 1992; Jap & Anderson, 2007; Cropper & Palmer, 2008; Rossignoli & Ricciardi, 2015). And several scholars of contracting have noted the evolution of both sourcing decisions and tendering capacity over time (Lamothe et al., 2008; Yang et al., 2009). Nevertheless, time and timing are rarely accounted for in existing impact evaluations of collaborative public management.

On the one hand, increasing collaborative duration allows for one-off reform costs to elapse, experiential learning to accumulate, and greater familiarization (and possibly trust) to develop among partners (Yang, et al., 2009). On the other, longer-term partnerships may not "move with the times" and adjust to changing conditions and priorities – especially if environments are dynamic or organizational inertia (perhaps also a product of age) restricts adaptation. Furthermore, older partnerships may receive less stringent oversight as collaborators gain "earned autonomy" from their sponsors, or staff turnover in the principal reduces monitoring capacity – again reducing performance.

As for the timing of collaborative inception, while the mix of advantages and disadvantages accruing to "first-movers" and "followers" in competitive industries has been much debated (Lieberman & Montgomery, 2013), these questions are largely overlooked in public administration, where swift accumulation of patents or market share are less relevant (an exception is Walker, 2004). However, institutional theories of organization provide an alternative mechanism for performance differences among early and late collaborators. Isomorphic pressure after initial reform diffusion may change the motivations, commitment, and contingency fit of late-stage adopters – potentially diluting the benefits of collaboration among "followers" more concerned with social conformity than authentic service innovation (Tolbert & Zucker, 1983; Kitchener, 2002).

Overall, then, successful collaboration may be *time*- as well as context-contingent; and taking greater account of the duration and timing of collaboration could improve performance evaluations significantly. We test this argument on two-wave panel data describing the cost of inter-municipal cooperatives in the Spanish region of Catalonia between 2000 and 2019. Overall, we find that intermunicipal cooperation is associated with lower service delivery costs compared with autonomous provision, especially in smaller municipalities. But the cost advantages decline over time as population growth weakens the need for collaboration among municipalities. Conversely, while the attributes of early- and late collaborators differ, this does not translate to a performance effect, with equivalent cost advantages attained by first-movers and followers alike. Nonetheless, younger collaborations are shown to be better adapted to new regulations on waste recycling.

The article proceeds thus. The second section reviews studies of inter-municipal cooperation, performance and contingency factors. The third develops the aforementioned arguments about time and timing, drawing on theories of environmental dynamism, inertia, accountability drift, and isomorphism. The fourth section describes the empirical context for the study, the fifth provides the data and methods, and the sixth presents the results. The discussion and conclusion then follow.

2. Inter-municipal cooperation and performance

Inter-municipal cooperation (hereafter IMC) involves two or more neighbouring or non-neighbouring local governments providing one or more public service(s) jointly across their respective jurisdictions (Hulst & van Montfort, 2012; Spicer, 2017; Tavares & Feiock, 2017; Teles & Swianiewicz, 2018). IMC is thus a subtype of collaborative public management, used primarily in polycentric systems of governance to facilitate regional coordination or address "scale" interdependences – that is, size-related cost reductions obtainable through the increased activity levels brought by collaboration (Elston, et al., 2018). This dual efficiency-regionalism rationale for IMC was provided six decades ago by Vincent Ostrom et al. (1961), who argued that, because many local services are subject to scale economies and spill-over effects, suboptimal municipal size can impede productive efficiency and the internalization of externalities (see also Dixit, 1973). By selective amalgamation of duplicative activities across different local units, cooperation may achieve greater efficiency than municipalities can attain individually – termed "collaborative efficiency" (Elston, et al., 2018; Zeemering, 2019) – without the need for boundary reforms. (IMC has also been used to pursue service quality and resilience objectives, see Holum and Jakobsen (2016); Aldag and Warner (2018); Warner et al. (2020); Arntsen et al. (2021); Elston and Bel (2022).)

In line with the Ostrom hypothesis, many empirical studies report a negative association between inter-municipal cooperation and costs, although the presence and size of this effect is conditional upon a number of contingency factors (for literature reviews and meta-regressions, see Bel and Warner (2015, 2016); Silvestre, et al. (2018); Bel and Sebő (2021)). In particular, collaborative efficiency first requires that services be subject to economies of scale (e.g., due to fixed costs), and, second, that low municipal population be inhibiting the attainment of those economies. Niaounakis and Blank (2017), for instance, found that joint tax administration among Dutch municipalities was efficient for IMCs serving up to (but not over) 60,000 inhabitants. Conversely, Dixon and Elston (2019) found no such benefit among district councils in England, where the average jurisdictional population exceeds 100,000.

As for the effect of time and timing on IMC performance, little research has been undertaken. In the related field of local outsourcing (which IMC is often presented as an alternative to), several studies show the beneficial effects of privatization to diminish over time (Bel & Costas, 2006; Dijkgraaf & Gradus, 2008; Bel et al., 2010; Petersen et al., 2018). But only Aldag et al. (2020) explore whether cost performance is maintained, improved or eroded dynamically in IMCs, and only as a post hoc analysis. (They found that five out of twelve services achieved collaborative costs savings, three of which increases these over time (police, libraries, and roads), one (sewers) decreased, and one (waste collection – our empirical case) was highly volatile.) Moreover, *timing* of collaborative adoption within a broader reform trend is entirely unstudied in the literature on IMC.

3. Dynamics effects in inter-organizational relations

3a. Collaborative duration

In "rational-instrumental" terms, collaboration should help organizations gain influence over interdependencies that exist with the "environment." Organizational environments are "all elements that exist outside the boundary of the organization and have the potential to affect all or part of the organization" (Daft et al., 2017). This includes other organizations influencing the availability or quality of resources, the success of core activities where there are task interconnections or negative externalities, or with whom there is potential to generate scale economies. Environments are dynamic (Aldrich, 2008; Andrews et al., 2012), meaning that their effects on organizations can vary over time. In extreme cases, large environmental disturbance might entirely remove the need for, or desirability of, inter-organizational collaboration – leading to partnership termination (Seabright, et al., 1992).

Alternatively, the collaboration may be retained but downsized, have its membership altered, or be otherwise reformed to reflect the shift in external interdependence.

However, inertia may inhibit rapid and extensive adaptation. According to Hannan and Freeman (1984, p.151), inertia occurs "when the speed of re-organization is much lower than the rate at which environmental conditions change." This is particularly associated with older (Le Mens et al., 2015) and larger (Hannan & Freeman, 1984) organizations (or parts thereof), as well as those that are more formalized (Walsh & Dewar, 1987) or tightly coupled (Barnett & Freeman, 2001). Inertia can also arise in collaborations – known as "network inertia" (Tai-Young et al., 2006) – if partners develop "organizational and individual attachments to an exchange" (Ring & van de Ven, 1994, p.107). Such "lock-in" to existing potentially "outmoded" collaborative arrangements arises due to sunk costs, limited management capacity for identifying new partners or re-negotiating agreements, or lack of feasible alternatives. And there may be inter-personal affective ties between staff from different partners, "curtailing the exploration of available alternatives, and more generally enhancing immobility" (Seabright, et al., 1992, p.127).

As well as inertia, a partnership may experience strong "imprinting" effects, whereby its objectives, culture, technology and routines are indelibly orientated towards conditions prevalent at its formation. According to Marquis and Tilcsik (2013), imprinting is "a process whereby, during a brief period of susceptibility, a focal entity develops characteristics that reflect prominent features of the environment, and these characteristics continue to persist despite significant environmental changes in subsequent periods." In other words, founding "blueprints" may restrict subsequent development of a collaboration, preventing functional adaptations in response to changed environmental conditions and/or dependencies, and again adversely affecting performance over time.

Lastly, collaborative results may decline if external oversight and accountability gradually weaken, reducing incentives and/or capacity for adaptation. According to Talay and Akdeniz (2014, p.87), "As an inter-organizational relationship ages, controlling mechanisms tend to become looser." In the case of IMCs, many authors already suggest that multi-jurisdictional service provision presents inherent accountability challenges (Spicer, 2017; Van Genugten et al., 2020). Because multiple principals employ a "common agent," overseers may free ride on each other's monitoring, increasing agent discretion (Voorn et al., 2019). This is compounded by the part-time nature of councillors and multipurpose nature of councils, both of which impede oversight (Schillemans & Busuioc, 2015; Busuioc & Lodge, 2016). Still, there are at least three mechanisms by which accountability problems could *worsen* over time, reducing the capacity for learning and incentives for improvement.

First is that aging delegations may attain "earned autonomy" (Ellwood, 2014), whereby adequate initial performance leads to less intense monitoring thereafter. Earned autonomy both incentivizes satisfactory (early) performance by agents and allows principals to reduce long-term monitoring costs. Reduced oversight might then undermine future performance, and detecting and correcting this decline may in turn be delayed by infrequent monitoring.

Second is the problem of changeover in principals over time. Without personal involvement in the initial decision to delegate, and direct experience of its early moments, a newlyappointed “nominal principal” may be less willing or able to oversee their predecessor’s reform, as Schillemans and Busuioc (2015, p.208) argue:

> “The extent to which the nominal principal is also the delegating principal, or to the contrary, the principal has changed over time and … its priorities and understandings of “appropriate” agent behavior (and even of the delegation process itself) … changed as well, is probably decisive [for predicting the assiduity of performance monitoring.]”

Since the transition from “founding” to “nominal” principal becomes increasingly likely over time, so might external pressure for IMC adaptation and improvement diminish.

The third and related problem is that of “brain drain.” As Van Genugten, et al. (2020, p.9) argue, “when creating a stand-alone organisation, staff and expertise often moves to this new organisation … leav[ing] municipalities … without the necessary expertise to manage these arm’s-length bodies.” This problem, familiar from the literature on outsourcing (Van Slyke, 2003; Bovaird, 2016), has at least two consequences for performance dynamics. First is to create the kind of organizational “lock-in” to inefficient exchanges already described (Lamothe, et al., 2008). Second is to further impede monitoring, especially for complex services that require esoteric knowledge to truly interrogate performance (Grimshaw et al., 2002, p.495).

To summarize, the benefits of IMC service provision may diminish over time due to the evolution of organization-environmental interdependencies, the presence of inertia or imprinting that slows or restricts adaptation to these changes, and the multiple risks of accountability "drift."

H1: The cost advantage of inter-municipal service provision diminishes over time (Hypothesis 1)

3b. Timing of collaborative inception

As well as duration, the timing of partnership formation may also explain collaborative performance. Monopolizing of technological innovations through swift patenting and pre-emptive acquisition of critical assets are typically cited in support of first-mover advantage in industry (Suarez & Lanzolla, 2005; Lieberman & Montgomery, 2013). Conversely, "follower advantage" arises when late adopters benefit from learning undertaken by the first-movers without incurring the same costs or risks. Few have questioned whether such innovator-follower dynamics, driven by market competition, apply in the public sector; although Walker (2004) pointed to service outsourcing and intra-government competition for resources as reasons for investigating first-mover advantages in the public sector. However, the institutional theory of organizations provides an alternative mechanism predicting differential performance among early and late participants in a public management reform trend, using markedly differing assumptions.

Institutionalists argue that demonstrating legitimacy to external stakeholders is a vital additional consideration for managers, alongside operating efficiency, since this provides both access to resources and protection from thorough regulatory scrutiny (Meyer &

Rowan, 1977). Organizational legitimacy is a "generalized perception or assumption that the actions of an entity are desirable, proper, or appropriate within some socially constructed system of norms, values, beliefs, and definitions" (Suchman, 1995, p.574). Overt goal attainment may contribute to *output* legitimacy; but legitimacy is judged from *behaviours* as well as results, especially when performance is delayed and difficult to measure or attribute (Meyer et al., 1983). By conforming to widely accepted "templates" of what desirable and effective organizing looks like – "rationalized myths," in Meyer and Rowan's (1977, p.343) language – organizations demonstrate their compliance with societal expectations.

Some of the earliest institutionalist studies explored the diffusion of reforms through organizational fields, positing differing intentions for those adopting the reform at either end of the trajectory (Tolbert & Zucker, 1983). As Kennedy and Fiss (2009, p.897) summarize, this work argued that "early adopters seek technical gains from adoption, but later adopters are primarily interested in the social benefits of appearing legitimate," following the example set by the innovators irrespective of its functionality. This "two-stage" model of diffusion suggests that early and late adopters have dissimilar *motivations* for reform (problem-solving, versus legitimacy-enhancing); different *commitment* to reform (problem-satisficing, versus superficial compliance); and differing degrees of *contingency fit* between reform and local circumstances (tailored solutions, versus generic "recipes"). These differences may affect collaborative performance. In particular, if "followers" adopt collaborative relations that are less driven by problem-solving, involve only superficial and symbolic changes to routines and practices (known as "decoupling," see Boxenbaum and Jonsson (2008)), and/or ignore local contingency factors necessary for reform success (e.g., a cost function and population size that is conducive to up-scaling through IMC), late adopters may perform worse than first-movers:

H2: The cost advantage of inter-municipal service provision is higher among early-stage than late-stage collaborators (Hypothesis 2)

4. Geographical, institutional and regulatory context

Our test of these two potential dynamic effects – collaborative duration, and timing of collaborative inception – is conducted on data from Catalonia, a region in north-eastern Spain with a population of 7.5 million. Spanish local government is structured in a two-tier arrangement. In Catalonia, this consists of four provinces and 947 municipalities. In 1987, the Catalan parliament also established counties (“*comarques”*) as an intermediate level, with each municipality sitting within one of 42 counties. The counties provide territorial services that have been deconcentrated by the Catalan government, and also municipal services that are delegated by several (not necessarily all) municipalities in the county. Over three decades, counties have become the predominant method of inter-municipal cooperation in Catalonia (as well as in the neighbouring region of Aragon), because of a widespread push for intermunicipal cooperation through counties, in which successive regional governments have played a leading role. Counties have no power to raise revenue, and are financed by regional transfers and payments from participating municipalities.

Voluntary associations of municipalities (“*mancomunitats”*) that are jointly governed by members are also used for inter-municipal provision, although to a lesser extent than in other regions where county councils do not exist (Bel et al., forthcoming; Zafra-Gómez et al., 2013; Pérez-López et al., 2015). Mancommunities have the power to raise revenue, like voluntary unions in other countries (for instance in Italy (Bocchino and Padovani, 2021)). In Catalonia, however, they are more often financed by transfers from participating municipalities.

Spanish law requires municipalities to provide waste management services (Law 1986), including both collection and transportation (hereafter: collection) and waste valorisation (hereinafter: treatment). Due to the significant facilities required, treatment is usually managed at county or inter-county level; or, for municipalities in the Metropolitan Area of Barcelona (AMB), by the Environment Metropolitan Entity-AMB. Waste collection, on the other hand, remains a municipal responsibility, undertaken either as a stand-alone provision (i.e., by a single municipality serving a single jurisdiction) provision, or inter-municipally – through either the counties or voluntary associations already described. Stand-alone provision may involve either public, or mixed production. For county-level provision, county governments determine mode of production: public, private or mixed. For voluntary associations, the participant municipalities jointly decide on mode of production.

5. Empirical strategy

5a Data and sources

We study the cost dynamics of IMCs in solid waste collection in Catalonia between 2000 and 2019, focusing on service delivery costs. Since regulation of waste management is a regional power, potential regulatory changes over this period applied to all municipalities in our study. Administrative data on volume and types of waste collected are published by the regional environmental agency (*Agència de Residus de Catalunya*) since the late 1990s, but data on costs is only available since 2015 (from the Spanish Ministry of Finance) and only for a fraction of municipalities. Consequently, we built the database as follows.

First, our baseline comes from the dataset used in Bel and Costas (2006), which includes information on waste collection costs and other relevant variables (provider, producer, and frequency of waste collection) collected by survey instrument for 186 Catalan municipalities with a population >1,000 in the year 2000 (details in the appendix).

Second, we administered a new and equivalent survey specifically directed to those 186 municipalities for which information for 2000 was available. We obtained data on waste for 2019, enabling a comparison over the space of two decades. (Details on the timeline and methodology of the second-wave survey are provided in the appendix.) Counties provided supplementary data for the municipalities in the database.

Third, we obtained supplementary data on service costs and characteristics from four mancommunities (Cardener, La Plana, Penedès-Garraf, and Urgellet) and the Environment Entity of the Metropolitan Area of Barcelona (AMB); on waste volumes and types and on facilities from the Catalan Waste Agency; and on local demographic and economic characteristics from the Spanish and Catalan Statistic Institutes.

In all, the database comprises 178 municipalities, for which we have data for 2000 and 2019. This represents 95.7% of the municipalities initially targeted. Table SM1 in the appendix shows representativeness of Catalan municipalities (above 1,000 inhabitants). Our database includes municipalities in 34 out of the 42 Catalan counties. Population in the eight counties not in the database is 73,276 inhabitants (1% of total population in Catalonia) and they include 110 municipalities (11.6% of total). Most excluded counties are in the north-west of Catalonia (province of Lleida), in the Pyrenees and pre-Pyrenees area, which is sparsely populated.

Within our dataset, the number of cooperating municipalities in 2019 is 82 (46.1% of our sample in 2019), compared with 67 (37.6% in 2000). Cooperation is more frequent in smaller municipalities (68% below 10,000 inhabitants; 57% below 20,000) than in larger municipalities (17% above 20,000 inhabitants). Therefore, by weighting representativeness of municipalities in our database, frequency of cooperation would be above 60%.

5b. Variables and methods

We follow the methodology proposed in Stevens' (1978) seminal article on waste collection costs and production choices, as well as the cost function proposed in Bel and Costas (2006), which allows analysis of the effect of provision choice[1] and is now common in empirical studies (see Bel and Sebő (2021)). Our dependent variable, annual service costs (inclusive of

[1] For the basic equation we use the same variables as in Bel and Costas (2006), except for provincial wage level. Local-level wage estimates do not exist in Spain. Provincial level estimates were provided by the Savings Banks Foundation (*Funcas*) until 2010 and is no longer available.

employee, capital, and overhead costs), is accrual-based, and is taken from the two rounds of surveys. We adjust costs of 2000 with the cumulated inflation between 2000 and 2019 in Catalonia (Consumer Price Indexes are not provided at municipal level), which was 58.2% (Spanish Statistical Institute, INE). Our explanatory variables are as follows:

Cooperation (Coop): Our key independent variable is a dummy, taking the value 1 when waste collection is provided inter-municipally (whether county or voluntary association), and 0 otherwise.

Private production (Priv). Production choices may influence costs. IMC (a form of *provision*) is compatible with both public and with private modes of *production*. PRIV is a dummy variable that takes value 1 when service delivery is by private firm(s),[2] and 0 otherwise. Our expectation for this variable is ambiguous because the literature presents diverse results. Past studies for our geographical and institutional context have found this variable not significant (Bel, et al., 2010).

*Volume of waste collected (*Vol*),* as it has been found as primary factor of collection costs in the empirical literature.

Percentage of selected waste (PcSel). Waste recycling has been promoted during the study period, decreasing the overall social costs of waste management but increasing monetary costs of collection due to the additional burden of selective collection (Bohm et al, 2010).

[2] In a minority of cases, waste collection is managed by a mixed public-private firm. We therefore define private control as when the private firm holds the majority of shares in the mixed firm.

Frequency of waste collection (Freq): Number of weekdays with waste collection, expected to positively influence costs (as in Bel and Costas, 2006).

Density of population (PopDens): Number of inhabitants per square kilometre. Greater dispersion reduces the volume of waste collected at each stop; but a large concentration of population can impose traffic congestion costs.

Tourism (Tou): Tourism is a significant economic activity in Catalonia, albeit geographically concentrated and heavily seasonal. Waste collection in high season can disrupt regular services, increasing costs as municipalities require additional resources (increased workforce, more mobile equipment, etc.). As in Bel and Costas (2006), we expect tourism to increase costs. Data for the tourist index in 2000 was obtained from La Caixa Statistical Yearbook for 2000. Unavailable for 2019, we rebuilt the index based on data from the Catalan Statistical Institute.

Waste Reception Facilities (WRFac): Having waste reception facilities within the municipal boundary can decrease transportation costs.

Table 1 summarizes our variables and sources.

(table 1 around here)

5c. Methodology

To test whether cooperative provision affected financial performance, and the dynamics of any effects, we specify the following type of model for waste collection costs:

$$WCTC_i = \beta_0 \, Vol_i^{\beta_1} \, PcSel_i^{\beta_2} \, PopDens_i^{\beta_3} \, Freq_i^{\beta_4} \, e^{(\beta_5 Tou_i + \beta_6 Fac_i + \beta_7 Priv_i + \beta_8 Coop_i)} \quad (1)$$

The tourist index is a continuous variable yet contains observations with value 0, meaning that it cannot be logarithmically transformed. We thus estimate the double-logarithmic form of equation (1):

$$logWCTC_{it} = \beta_0 + \beta_1 \, logVol_{it} + \beta_2 \, logPcSel_{it} + \beta_3 \, logPopDens_{it} + \beta_4 \, logFreq_{it} + \beta_5 \, Tou_{it} + \beta_6 \, WRFac_{it} + \beta_7 \, Priv_{it} + \beta_8 \, Coop_{it} + \varepsilon_{it} \quad (2)$$

Where sub-script *i* represents the municipality, sub-script *t* represents year (2000 and 2019), and ε is a heteroscedasticity-robust error term. We use natural logarithms. Descriptive statistics are provided in Table 2.

(table 2 around here)

To check the robustness of our analysis, and to obtain additional direct information on cost-efficiency terms and economies of scale, we use a second dependent variable, Cost per Tonne, which is the ratio of total costs (as defined above) divide by tonnes of waste collected. We estimate the equation 2.b, where all independent variables are as defined above.

$$WCCxT_{it} = \beta_0 + \beta_1\, logVol_{it} + \beta_2\, logPcSel_{it} + \beta_3\, logPopDens_{it} + \beta_4\, logFreq_{it} + \beta_5\, Tou_{it} + \beta_6\, WRFac_{it} + \beta_7\, Priv_{it} + \beta_8\, Coop_{it} + \varepsilon_{it} \qquad (2B)$$

We conduct robust estimations to control for heteroskedasticity when advised by the Breusch-Pagan/Cook-Weisberg test. The average Variance Inflation Factor (VIF) is 2.38, and all single variables have an individual VIF below 4. Therefore, we do not have relevant issues of multicollinearity. Our database has a panel structure. The Breusch and Pagan's LM tests for random effects was significant at 5%, so that panel estimation is preferred to OLS in the estimation for total costs for the full sample. We controlled for time effects by including a year dummy (which takes value 1 for 2019).

Bel and Costas (2006) found structural change to exist, so that the equation is different depending on dimension of population and waste volume. Consequently, we segment our sample as follows: all municipalities below 10,000 inhabitants; all municipalities below 20,000 inhabitants; all municipalities with population above 20,000 inhabitants. In all three cases, the Breusch and Pagan's LM tests for random effects was not statistically significant ($p>0.05$); therefore, pooled and clustered OLS estimations were preferred to GLS random effects. Time effects were controlled here, as well. In all three cases we checked results from the GLS random-effects estimations, and they were practically identical to the pooled and clustered OLS estimations.

6. Results

6a. Effect of collaborative duration on financial performance

Table 3A presents results from the estimations for our full sample (2000 and 2019 combined), and for the population-defined subsamples explained above. We also include the OLS clustered estimation for the whole sample to facilitate comparison of results with estimations for the subsamples. Results for the Ramsey Reset test ($p<0.05$) suggest that missing variables exist for estimation of the full sample.

Explanatory capacity is always very high, as expected, because volume and percentage of selection drive production costs. In the estimation for the complete sample (all municipalities, column 1) for these two variables are positive and significant at 1‰, as is frequency of collection. Our key explanatory variable, *Cooperation*, has negative sign, but its significance is very weak ($p=0.090$). Other control variables such as population density, facilities, and private delivery are not significant.

(Insert table 3A)

Columns 2, 3, and 4 in table 3A display the results for subsamples based on population thresholds. The Chow-Test of structural change leads us to reject at 1‰ significant level the hypothesis that there is no structural change, so that we accept the alternative hypothesis that the equation differs depending on municipal population (we conducted the test with 20,000 inhabitants as threshold, consistent with previous results in Dijkgraaf et al. (2003)

and Bel and Costas (2006)). Cooperation is negative and significant for municipalities below 10,000 (column 2, p<0.05) and below 20,000 inhabitants (column 3; p<0.01). All other results are identical, except for *tourism,* which is now positive and highly significant. For municipalities above 20,000 (column 4), however, Cooperation is far from statistically significant, and tourism appears to be negatively related to costs. Again, the sign of coefficients and their statistical significance are virtually identical for the estimates with both dependent variables.

Table 3B shows the results for our estimations with Cost per Tonne as the dependent variable. Column 5B presents the results for the OLS pooled clustered estimations (which is here preferred to the GLS estimation according to the Breusch and Pagan's LM test). Results are virtually identical to those obtained with Total Cost as the dependent variable, except for Volume, which suggests that no economies of scale exist for the full sample. The results of the subsamples based on the population (columns 6, 7 and 8) are virtually identical to those obtained with Total Cost as dependent variable. The coefficient and significance of the variable volume indicate that economies of scale are significant below 20,000 inhabitants, but not above this population threshold (nor for the full sample). The Ramsey Test for omitted variables suggest that this issue is more relevant when we estimate with cost per tonne as dependent variable than when we used total cost.

(Insert table 3B)

In all, our results show that Cooperation is associated with lower costs for less populated municipalities, which produce lower volumes of waste. Coefficients for waste volume from the estimations of municipalities below 10,000 and below 20,000 indicate that economies of scale exist (significant at 1‰ level, as can be seen in columns 6 and 7 in table 3B), whereas economies of scale do not exist for municipalities above 20,000 inhabitants.[3]

Turning to evidence on dynamic effects (Hypothesis 1), the cost advantages of cooperative provision, while strongly significant for smaller municipalities in our full sample (columns 2, 3, 6, and 7), are smaller in dimension and statistical power than those we found for the subsample of the municipalities in year 2000, as can be seen in table 4. In this case, our subsample does not have a panel nature, so that we run OLS regressions. As in the case of the full sample, all estimations are significant, the Ramsey Reset test results indicate that there are not significant variables missing in the model, and explanatory capacity is very high. (For simplicity, we do not include here the results of the estimates with Cost for Tonne as dependent variable (recall that Ramsey-Reset Test rejected the hypothesis that there are not missing variables for all these estimations, except that for municipalities above 20,000 inhabitants). They are virtually identical to those presented in table 4, and the variable *volume* is negative and significant in the estimations for municipalities below 20,000 inhabitants, indicating economies of scale (results are available upon request).

(Insert table 4)

The results for our key variable, Cooperation, differ in two directions: first, it has a negative and strongly significant ($p<0.001$) effect on costs for the estimation with all municipalities in

[3] The variable *PopDens* has a correlation of 0.82 with *Volume*. Although this relationship does not affect our key *variable Cooperation,* to ensure that it did not influence the coefficient for volume, as per the results of the test for scale economies, we re-estimate all models without the variable density (which was not significant in the estimations in table 4). The results were identical for signs and significance, and the results for scale economies were not altered in any case (available upon request).

the year 2000 (columns 9), different from our results for the complete sample (columns 1 and 1b in table 3A). Second, statistical significance is generally higher (p<0.001) and so is the effect on costs (coefficients are also higher, in absolute values) for cooperation in estimations for municipalities below 10,000 (column 10) and 20,000 inhabitants (column 11). This suggests that cost saving effects from cooperation have diminished through the two last decades. (Results for municipalities above 20,000 inhabitants (column 12) are identical to those obtained for the whole 2000-2019 sample (column 4, in table 3A), as the coefficient is not significant. Furthermore, if we estimate our model only for 2019 (columns 13 to 16 in table 4), cooperation does not show any significant relationship with costs, either for the estimation with all municipalities (column 13), or for smaller municipalities (columns 14 and 15). This provides additional evidence that IMC has lost some cost advantage, as predicted by Hypothesis 1. Moreover, the test for structural change indicates that the model is different for each year.[4]

6b. Effect of timing of collaborative inception on financial performance

Turning now to the effect of reform timing on delivery costs (Hypothesis 2), we test for different outcomes between early-adopters and followers by decomposing our cooperation variable to reflect the era during which the cooperative strategy was pursued. As mentioned, cooperating municipalities in our database grew from 67 (37.6%) to 82 (46.1%)

[4] Data on the different types of IMC governance (counties or voluntary associations) was not recorded in the baseline (2000) survey, so no estimation with that comparison can be made for the whole sample. The 2019 survey did obtain that data, with 71 municipalities cooperating through counties and 11 through voluntary associations. We thus disaggregated the *Cooperation* variable into *Coop_County* and *Coop_Mancommunity, and re-ran the 2019 estimations*. Results (included as table SM2 in the online appendix) suggest cost savings with voluntary associations compared with stand-alone provision, while cooperation through counties does not show difference in costs, consistent with results for year 2019 in table 4 above.

between 2000 and 2019, with 22 municipalities joining IMCs post-2000 ("late adopters"), and seven municipalities terminating their arrangements ("decooperators"), producing the net addition of 15. Sixty municipalities cooperated continually across 2000-2019 ("permanent cooperators"),[5] and 89 retained autonomous provision throughout. We therefore decompose the variable 'Cooperation' into: (1) *In_coop* (late-stage adopters, reforming after 2000), and (2) *Early _adopters* (permanent_cooperators and decooperators). We then formulate an additional model to analyse factors explaining changes in costs between 2000 and 2019, and compare early adopters with followers:

$$Dif\_WCTC_i = \beta_0 + \beta_1 Dif\_Vol_i + \beta_2 Dif\_PcSel_i + \beta_3 Dif\_PopDens_i + \beta_4 Dif\_Freq_i + \beta_5 Dif\_Tou_i + \beta_6 Dif\_WRFac_i + \beta_7 PrivChange_i + \beta_8 In\_Coop_i + \beta_9 Early\_Adopters_i + \varepsilon_i \quad (3)$$

where non-organizational variables take as value its difference between 2019 and 2000; $PrivChange_i$ is a dummy variable that takes value 1 if the municipality switched between private and public delivery (any direction); *In_Coop*, is a dummy variable that takes value 1 when the municipality has moved from stand-alone to cooperative provision, and 0 otherwise; *Early_Adopters* is a dummy variable that takes value 1 when the municipality was cooperating in 2000, and 0 otherwise; and *Never_Coop*, which is the reference category, when the municipality used stand-alone provision throughout the period. Furthermore, we modify model (3) by decomposing Early_Adopters in *Permanent_Cooperators* and *Decooperators*.

[5] Importantly, IMC in waste collection in Catalonia is not implemented by institutionalized cooperation, membership of which is less volatile than interlocal contracts. Municipalities cannot switch easily from one to another cooperation arrangement (because they cannot switch from one county to another at their own will). Furthermore, our survey contained an explicit question about potential previous experiences of cooperation. Therefore, the information on cooperative status obtained in our municipalities is highly stable and reliable.

$$Dif\_WCTC_i = \beta_0 + \beta_1\, Dif\_Vol_i + \beta_2\, Dif\_PcSel_i + \beta_3\, Dif\_PopDens_i + \beta_4\, Dif\_Freq_i + \beta_5\, Dif\_Tou_i + \beta_6\, Dif\_WRFac_i + \beta_7\, PrivChange_i + \beta_8\, In\_Coop_i + \beta_9\, De\_Coop_i + \beta_{10}\, Permanent\_Coop_i + \varepsilon_i \quad (4)$$

Where all variables are the same as in (3) with the exception of the above indicated replacement. In (3b) *De_Coop,* which is a dummy that takes value 1 when the municipality has moved from cooperative to stand-alone provision, and 0 otherwise; *Permanent_Coop* is a dummy that takes value 1 when the municipality used cooperation throughout, and 0 otherwise.

By estimating this equation, we observe the potential effects of changing form of provision (*In_Coop* and *De_Coop*) with respect to municipalities that have always used stand-alone provision (*Never_Coop*)*,* which is the reference category. Furthermore, by re-estimating the equations changing the reference category, we can compare any stage of cooperation (permanent, late, and de-cooperation) with any other stage of adoption (or termination).

Table 5 presents the results. Estimations for municipalities above 20,000 are identical, as decooperators do not exist in this segment (therefore, we omit column 24 for the sake of simplicity, as it would be equivalent to column 20).

(Insert table 5)

As in all cases above, estimations are highly significant and explanatory power remains reasonably high, although lower than before. Tests for structural change again indicate that the equation is different depending on population. In this case, however, in all estimations except for municipalities below 20,000 inhabitants (in both models) the Ramsey-Reset test rejects the hypothesis that the model does not omit significant values, which advises caution when interpreting the results. Volume of waste collected is the main explanatory factor for change in costs overtime.

Both *early_adopters* and *followers* show cost advantages with respect to *never_cooperators* in the most robust estimation (column 19, municipalities below <20,000, for which the Ramsey Test does not reject non-omitted variables). But, contrary to Hypothesis 2, no significant differences in change in costs are found between *early_adopters* and *followers.*

Turning to results from our decomposition in Table 5, service delivery costs in returning to stand-alone provision during 2000-2019 (De_coop) grew less than in those municipalities that never used cooperation (Never_coop). Similarly, costs in municipalities that always cooperated (Permanent_coop) grew less than in the municipalities that never cooperate (with the exception of the estimation for all municipalities, which is our less preferred estimation given the test of structural change). Results for municipalities that switched from stand-alone to cooperative provision (i.e. the "followers") are less stable, and only show a negative and significant result (as compared with municipalities that never cooperate) in the estimation for municipalities below 20,000 inhabitants (column 19). (Note again that this is our preferred estimation, because the Ramsey-Reset test does not allow to reject that the model does not omit significant variables.) Finally, there do not exist other significant associations when we compare variables related to the collaborative status of the municipality, as indicated in table SM3 in the appendix.

7. Discussion

Based on theories of environmental dynamism, inertia, imprinting, and accountability drift, we hypothesized that the comparative advantage of IMC provision could diminish over time, as suggested by several studies regarding the long-term effects of local privatization (Bel & Costas, 2006; Dijkgraaf & Gradus, 2008; Bel, et al., 2010; Petersen, et al., 2018). Our results support this “rusting” hypothesis: Cooperative provision in Catalonia is associated with lower costs than stand-alone provision for municipalities of lower population, but the significance and dimension of this cost advantage diminished between 2000 and 2019.

Of the several mechanisms potentially responsible for this decline, shifts in the external environment and commensurate changes in inter-municipal interdependencies seem most relevant. Both average population and average volume of waste collected increased between 2000 and 2019, from 26,514 to 31,526 inhabitants (18.9% increase), and from 13,799 to 15,249 tons (10.5%), per municipality. However, those municipalities opting for cooperative provision in 2000 experienced far larger growth than the average – from 4,819 to 7,317 inhabitants (51.8%) and from 2,407 to 3,764 tonnes (56.4%) (see Table 6, rows 1-2). As such, the scale diseconomies suffered by the collaborators in 2000 ha reduced markedly by 2019, lessening the co-reliance – or “interdependence” – between neighbours to generate volume-based efficiencies.

Concerning inertia, while our data does not allow us to observe what incremental changes in management and governance arrangements IMCs adopted in response to their reducing interdependence, we do have seven cases of outright partnership termination (“de-cooperation"). Average population growth in this small group was 34.0% - larger than for the 60 "permanent co-operators" who retained the IMC model despite average population growth of 27.7% (Table 6, columns 3 and 5). Thus, inertia did not prevent reform reversal among municipalities with most significantly reduced external interdependence.

(Insert table 6)

Regarding "imprinting" effects: after population growth, a second dimension of environmental change during 2000-2019 was increased regulation of environmental sustainability and recycling. So-called "selective collection" is costlier to implement, and municipalities require sufficient administrative capacity to manage incentive schemes introduced by higher tiers of government. So, did early-adopter IMCs escape their founding blueprints (i.e., little regulation of recycling) by re-orientating to provide comparative advantage on sustainability as well as costs? In 2000, selective collection stood at about 11%, with no appreciable difference between cooperating and autonomous municipalities. By, 2019 cooperating municipalities had an average of 54.4% of selective collection, higher than for non-cooperative municipalities, at 44.8% (a difference statistically significant at $p<0.01$). Moreover, late adopters decreased their waste/inhabitant ratios and increased selective collection more than any other group (see Table 8), indicating that "follower" IMCs that formed post-2000 and during the era of heightening concern for sustainability were indeed imprinted differently than pre-2000 IMCs.

Lastly on Hypothesis 1, while we have no direct measure of accountability drift, prior research suggests that institutional arrangements in Catalonia reduces problems of “common agency”, since this allows better aligning the interests of the governing board with those of the median principal (Voorn, et al., 2019; Bel & Sebő, 2021).

Turning to Hypothesis 2, we suggested that differences in motivation and commitment might contribute to different outcomes among first-movers and followers, building on the institutionalist view of organizational reform. While collaboration is often described in purely “rational-instrumental” concerns as a reform solution to an identifiable problem, a growing body of research points to an alternative, symbolic, and image-enhancing basis for collaboration (Rodríguez et al., 2007; Skelcher & Sullivan, 2008; Dickinson & Sullivan, 2014; Jacobsen, 2015; Dixon & Elston, 2020). But no study has yet exploited longitudinal data and the canonical “two-stage” method of the early institutionalist literature (Tolbert & Zucker, 1983) to test quantitively this emerging, more critical perspective on collaborative public management.

Contrary to hypothesis 2, we found no significant difference in costs between early and late reformers, with equivalent cost advantages attained by first-movers and followers alike, compared with autonomous municipalities. However, somewhat in line with Tolbert and Zucker (1983), we do find differences between first-movers and followers in terms of “fitness” for reform. Recall that IMC is most suited to smaller municipalities suffering most from scale diseconomies, and that legitimacy-seeking behaviour is inferred when “city characteristics no longer predict the adoption decision” (Tolbert & Zucker, 1983, p.22). The 22 municipalities in our follower group were on average far larger than the early adopter group (4,871 versus 7,394 inhabitants) and thus were much less “prime candidates” for IMCs than those reforming prior to 2000, albeit still more suited than the never-cooperating municipalities (in 2019 figures: 10,475 versus 55,805; significant at $p<0.01$). But while somewhat indicative of the isomorphic logic, such a “staged” trajectory of reform diffusion (first to prime then to promising candidates) could also reflect more rational-instrumental patterns of diffusion based on trial-and-error and learning (Rogers, 1995), especially given the absence of a negative cost effect. So, isomorphism is implied but not proven.

8. Conclusion

Amid a growing literature evaluating collaborative public management strategies, and increased recognition that “seeking collaborative advantage is a seriously resource-consuming activity … only to be considered when the stakes are really worth pursuing” (Huxham & Vangen, 2005, p.13), we set out to test whether greater attention to variables related to time could improve econometric modelling of collaborative results. Though they remain significant, IMC cost advantages diminished over our twenty-year period, reflecting the significant population and waste-volume growth experienced by first-movers across 2000-19. Organizational or network inertia did not prevent those municipalities most affected from terminating their agreements in response to their reduced dependency on neighbours to generate efficient operating scale. But imprinting is evident to the extent that late reformers achieved partnerships that out-performed early-adopters on sustainability metrics, the importance of which grew significantly between 2000 and 2019. As for the timing of collaborative reform, while we did not find evidence of a cost differential between early and late adopters, followers were “promising” rather than “prime” candidates for IMC, which is somewhat indicative of isomorphic diffusion.

These results suggest several implications for both theory and practice.

First is that, when looking at collaboration dynamically, evaluators must not simply test for initial "disruption" effects, in which one-off reform costs act as a temporary drag on collaborative performance. Certainty, as Koppenjan (2008, p.708) argues, "Interactions can hardly be expected to take the right shape and produce results immediately. Collaborating parties have to undergo a learning curve, which takes time." But, as we have shown, it is also possible that any beneficial effects of collaboration begin to wear off longer-term. Thus, attention to performance dynamics *throughout* the collaborative life cycle is needed.

Secondly, regarding practical public management, our work suggests that inter-organizational collaborations might require different oversight regimes at different times. The danger with earned autonomy is that declining performance thereafter is harder to detect. Turnover in personnel, brain drain, and new policies and political priorities may all inhibit effective long-term oversight. And yet changing environmental conditions, coupled with inertia and imprinting effects, could lead to outmoded collaborative arrangements in which "form" no longer follows "function."

The analysis contains several important limitations that might be addressed in future research. With only two years of data, our tests of dynamic effects are far from granular. Key "moments" of the collaborative life cycle, such as the precise point of establishment, membership expansion, or dissolution, could not be studied, and nor could the proximity or delay of performance disruptions in response to these. A continuous time series would also allow use of alternative, quasi-experimental techniques, thus obtaining more robust results. In addition, we studied only one service area (solid waste collection), for which performance is relatively measurable, co-production with the public relatively limited, and interdependencies with other local services fairly contained. As with IMC research more generally, therefore, future analysis needs to seek out data on the other less-specifiable, more co-produced and interdependent public services that municipalities are increasingly vesting in collaborative structures. Finally, institutional theorists have increasingly reiterated that the legitimacy-driven organizational choices from which we formed hypotheses about reform timing do not necessarily entail objective performance loss (Kitchener, 2002). Moreover, legitimacy motivations and cannot be inferred solely from changes in reformer characteristics vis-à-vis peer organizations (Greenwood et al., 2008). As such, future research on leader and follower behaviour in public management reforms requires more sophisticated and possibly mixed-method research designs from which the influence of legitimacy and isomorphism can better be inferred.

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Table 1: Variables: definition and sources

Variables	Definition	Source
DepVar		
WCTC	Waste Collection Total Costs (€)	SLSP-UB and Survey-2019
IndVars		
Vol	Volume of waste collected (Tons)	Catalan Waste Agency (ARC)
PcSel	Percentage of waste selectively collected	Catalan Waste Agency (ARC)
PopDens	Density of population (inhabitants/km^2)	Spanish & Catalan statistical institutes (INE and Idescat)
Freq	Number of days with waste collection during the week	SLSP-UB & Survey-2019
Tou	Tourism Index	La Caixa Statistical Yearbook & Catalan Statistical Institute (Idescat)
WRFac	Waste reception facilities	Catalan Waste Agency (ARC)
Priv	Dummy variable with value 1 if the service is privately managed, and 0 otherwise.	SLSP-UB & Survey-2019
Coop	Dummy variable with value 1 if the service is cooperatively provided, and 0 otherwise.	SLSP-UB & Survey-2019

Note: ACR (Agència de Residus de Catalunya); INE (Instituto Nacional de Estadística); Idescat (Institut d'Estadística de Catalunya)

Table 2. Descriptive Statistics

Variables	Observations	Mean (count)	Standard Deviation (Percentage)	Minimum	Maximum
WCTC (€)	356	1611063.98	7261907.03	19560.26	95954602.56
Vol (Tons)	356	14523.99	59585.06	236.34	791618.42
PcSel	356	30.26	22.90	0.01	92.19
PopDens	356	1289.72	2937.17	14.68	21382.00
Freq	356	5.89	1.29	2	7
Tou	356	2.62	8.84	0	107.83
WRFac	356	(141)	(39.60)	0	1
Priv	356	(283)	(79.49)	0	1
Coop	356	(149)	(41.85)	0	1

Table 3A: Results for the complete sample (2000 & 2019). Dependent variable Total cost

	Column 1 (all) GLS Random clustered	Column 1B (all) Pooled and clustered OLS	Column 2 (pop<10,000) Pooled and clustered OLS	Column 3 (pop<20,000) Pooled and clustered OLS	Column 4 (pop>20,000) Pooled and clustered robust OLS
Volume	0.9753***	0.9788***	0.8571***	0.8816***	1.0496***
	(0.0234)	(0.0236)	(0.0362)	(0.0321)	(0.0315)
Selective	0.1735***	0.1735***	0.1797**	0.1691***	0.1289*
	(0.0382)	(0.0407)	(0.0504)	(0.0402)	(0.0633)
Pop_Density	-0.0023	-0.0047	0.0321	0.0071	-0.0174
	(0.0193)	(0.0194)	(0.0239)	(0.0236)	(0.0334)
Frequency	0.2731***	0.2729**	0.3336***	0.3374***	0.5496**
	(0.0779)	(0.0778)	(0.0887)	(0.0845)	(0.1523)
Tourism	-0.0003	0.0001	0.0236**	0.0119*	-0.0035**
	(0.0023)	(0.0023)	(0.0066)	(0.0052)	(0.0013)
WR_Facility	-0.0721	-0.0803	-0.0102	-0.0351	0.0059
	(0.0606)	(0.0632)	(0.0806)	(0.0724)	(0.0941)
Private	-0.0278	-0.0260	0.0076	-0.0096	-0.0155
	(0.0483)	(0.0485)	(0.0543)	(0.0491)	(0.1202)
Cooperation	-0.0765†	-0.0781†	-0.1080*	-0.1324**	0.0847
	(0.0451)	(0.0455)	(0.0490)	(0.0496)	(0.1109)
Year2019	0.1111	0.1066	0.1541	-0.0956	0.2524
	(0.0835)	(0.0867)	(0.1110)	(0.0930)	(0.1239)
Constant	3.9393***	3.9235***	4.4875***	4.4793***	2.9611***
	(0.1848)	(0.1864)	(0.2514)	(0.2266)	(0.3582)
Time	Yes	Yes	Yes	Yes	Yes
VIF	2.38	2.38	1.89	2.07	2.49
BPL Multiplier Test	0.0306*	0.0309*	0.1129	0.0699	0.3210
Groups	178	178	114	140	48
Observations	356	356	216	270	86
R^2	0.4342	0.9581	0.8727	0.9131	0.9246
Chi2	8218.51***	-	-	-	-
F-Test	-	922.09***	150.35***	300.18***	275.51***
Ramsey-Reset (p>F)	0.0118*	0.0118*	0.4600	0.5185	0.0802
Chow-Test Structural Change all vs < 20,000 and > 20,000: F=3.73***					

Notes: Standard Errors in parentheses. *** p<0.001; ** p<0.01; * p<0.05; † p<0.10

Table 3B: Results for the complete sample (2000 & 2019). Dependent variable=Cost per tonne

	Column 5 (all) GLS Random clustered	Column 5B (all) Pooled and clustered robust OLS	Column 6 (pop<10000) Pooled and clustered robust OLS	Column 7 (pop<10000) Pooled and clustered robust OLS	Column 8 (pop<20000) Pooled and clustered OLS
Volume	-2.8321	-2.5013	-14.6006***	-12.2152***	4.6571
	(2.4021)	(2.4268)	(3.4985)	(3.2266)	(3.3463)
Selective	18.0432***	17.9755***	19.2115**	17.7826***	13.3214*
	(4.3875)	(4.6002)	(5.8712)	(4.6559)	(6.1995)
Pop_Density	-0.5619	-0.8512	3.0367	0.2319	-2.1398
	(1.9800)	(1.9863)	(2.6419)	(2.5089)	3.2400
Frequency	23.9420**	24.3189**	30.3877**	30.1863***	57.2076***
	(7.5286)	(7.5312)	(8.7193)	(8.1689)	(13.8710)
Tourism	0.1102	0.1280	3.3205**	1.4550†	-0.2648**
	(0.2987)	(0.2927)	(1.1257)	(0.7670)	(0.0975)
WR_Facility	-3.8104	-4.2851	5.0899	1.6640	-2.5135
	(5.5521)	(5.6735)	(7.5516)	(6.6007)	(8.4791)
Private	-2.8323	-2.4973	1.4317	0.3039	-6.9028
	(4.7502)	(4.7015)	(5.7324)	(4.9674)	(11.1127)
Cooperation	-6.9299	-7.3802†	-11.8231*	-12.5443**	8.0272
	(4.4194)	(4.4545)	(5.0573)	(4.7400)	(11.3496)
Year2019	-13.7681	-13.3051	-22.7522†	-14.3345	-20.8119†
	(8.7991)	(9.0784)	(12.2819)	(9.9944)	(11.6527)
Constant	46.8114*	45.1080*	99.0821***	100.6540***	-56.6437
	(18.4317)	(18.6577)	(26.2261)	(22.4788)	(34.9451)
Time	Yes	Yes	Yes	Yes	Yes
VIF	2.38	2.38	1.89	2.07	2.49
BPL Multiplier Test	0.0637	0.0637	0.1848	0.1312	0.2465
Groups	178	178	114	140	48
Observations	356	356	216	270	86
R^2	0.1987	0.1725	0.3380	0.2684	0.1742
Chi2	52.87***	-	-	-	-
F-Test	-	5.77***	8.57***	7.88***	10.05***
Ramsey-Reset (p>F)	0.0084**	0.0084**	0.0001***	0.0002*	0.7818*
Chow-Test Structural Change all vs < 20,000 and > 20,000: F=3.76					

Notes: Standard Errors in parentheses. *** p<0.001; ** p<0.01; * p<0.05; † p<0.10

Table 4. Results for the subsamples of year 2000 and of year 2019

	Column 9 (all, 2000) OLS	Column 10 (pop<10,000, 2000) OLS	Column 11 (pop<20,000, 2000) OLS	Column 12 (pop>20,000, 2000) OLS	Column 13 (all, 2019) OLS	Column 14 (pop<10,000, 2019) OLS	Column 15 (pop<20,000, 2019) OLS	Column 16 (pop>20,000, 2019) OLS
Volume	0.9862***	0.8923***	0.9186***	0.9958***	0.9688***	0.8316***	0.8535***	1.0865***
	(0.0271)	(0.0467)	(0.0395)	(0.0283)	(0.0370)	(0.0560)	(0.0511)	(0.0718)
Selective	0.1134***	0.1480***	0.1166***	0.1531*	0.3907***	0.4108***	0.3963***	0.4004
	(0.0244)	(0.0273)	(0.0262)	(0.0571)	(0.0845)	(0.0845)	(0.0847)	(0.3080)
Pop_Density	0.0076	0.0190	0.0053	-0.0398	0.0089	0.0586	0.0229	0.0143
	(0.0222)	(0.0301)	(0.0277)	(0.0233)	(0.0274)	(0.0354)	(0.0312)	(0.0599)
Frequency	0.3304***	0.3771***	0.3764***	1.5635***	0.2200*	0.2041	0.2595*	0.3973
	(0.0883)	(0.0990)	(0.0975)	(0.3238)	(0.1082)	(0.1092)	(0.1112)	(0.3657)
Tourism	0.0106*	0.0258	0.0151	-0.0013	0.0002	0.0254***	0.0124**	-0.0035
	(0.0063)	(0.0168)	(0.0079)	(0.0074)	(0.0021)	(0.0060)	(0.0038)	(0.0026)
WR_Facility	-0.3729***	-0.7998***	-0.4722***	-0.2004*	0.0005	0.0662	0.0577	0.0710
	(0.0831)	(0.1491)	(0.1097)	(0.0809)	(0.0653)	(0.0673)	(0.0693)	(0.1814)
Private	-0.1218*	-0.0736	-0.1277	0.1079	-0.0009	0.0384	0.0193	-0.0692
	(0.0543)	(0.0670)	(0.0645)	(0.0638)	(0.0612)	(0.0686)	(0.0657)	(0.1380)
Cooperation	-0.1785***	-0.2450***	-0.2311***	0.0117	-0.0013	0.0339	-0.0502	0.0174
	(0.0498)	(0.0570)	(0.0548)	(0.0871)	(0.0620)	(0.0707)	(0.0666)	(0.1593)
Constant	3.4857***	3.9763***	3.9428***	1.1652	2.9615***	3.5202***	3.6264***	1.3782
	(0.1809)	(0.2637)	(0.2317)	(0.6302)	(0.4221)	(0.5074)	(0.4755)	(1.6894)
VIF	1.93	1.49	1.64	1.33	1.98	1.38	1.58	1.46
Observations	178	114	140	38	178	102	130	48
BM/CW Test	0.0789	0.7208	0.9977	0.1007	0.2603	0.4145	0.0711	0.4520
Adj. R^2	0.9731	0.9192	0.9405	0.9788	0.9479	0.8577	0.8970	0.8961
F-Test	802.43***	161.69***	275.75***	214.29***	384.04***	70.06***	131.74***	42.06***
Ramsey-Reset Test	0.1369	0.7284	0.8458	0.2542	0.0172*	0.4458	0.1930	0.6106
Chow-Test Structural Change 2000 & 2019 versus single 2000 and single 2019: F=4.76***								

Notes: Standard Errors in parentheses. *** p<0.001; ** p<0.01; * p<0.05

Table 5. Estimation for changes in costs between 2000 and 2019 (costs in euros of 2019)

	Column 17 (all) OLS robust	Column 18 (pop<10000) OLS robust	Column19 (pop<20000) OLS robust	Column 20 (pop>20000) OLS robust	Column 21 (all) OLS robust	Column 22 (pop<10000) OLS robust	Column 23 (pop<20000) OLS robust
Dif_Volume	1253.0**	125.0***	210.4***	1360.8***	1254.7**	125.7***	211.6***
	(369.9)	(32.0)	(20.0)	(347.5)	(369.3)	(33.8)	(20.3)
Dif_Selective	12353.2	1558.2	245.1	16165.9	13364.7	1571.5	294.3
	(10378.7)	(806.8)	(1226.5)	(89032.1)	(10606.6)	(798.3)	(1219.5)
Dif_Pop_Density	2426.7*	-60.4	32.9	4093.8	2511.4*	-59.6	43.1
	(1045.7)	(166.3)	(128.6)	(2165.9)	(1050.9)	(167.2)	(132.9)
Dif_Frequency	16348.6	3953.6	14207.8	-62702.8	10200.1	3904.3	13978.1
	(66588.8)	(8574.1)	(10783.4)	(443893.8)	(64744.6)	(8654.3)	(10846.2)
Dif_Tourism	-65811.0*	10841.1	5338.6	-113471.7**	-66571.0*	10834.47	5266.4
	(26039.9)	(6942.7)	(5153.8)	(33212.2)	(26137.9)	(6998.7)	(5197.8)
Dif_WR_Facility	-421754.3	-19353.1	25668.3	-849024.7	-416716.2	-19601.0	26031.1
	(386211.5)	(34843.8)	(38975.9)	(1745123)	(386074.3)	(35039.6)	(39256.3)
Private_Change	439123.4	23570.4	30225.7	4428956	608967.6	25118.8	36681.1
	(304258.4)	(28076.2)	(36770.7)	(2752831)	(337268.2)	(30645.6)	(37548.1)
In_Cooperation	-389710.2	-116515.2	-204644.0**	-2551161	-448106.3	-117171.1	-206538.0**
	(529144.5)	(63220.5)	(62752.6)	(2264653)	(528744.5)	(63565.2)	(63081.2)
Early_Adopters	139502.5	-154161.0*	-186618.1**	-3069413			
	(447244.8)	(45927.0)	(53688.8)	(1899633)			
Permanent_Coop					236684.6	-153687.2**	-181788.9**
					(460411.8)	(46879.9)	(55480.9)
De_coop					-983877.4*	-161440.2**	-225375.8**
					(562477.7)	(58336.4)	(77935.2)
Constant	-1109416	162952.1***	236699.8***	-1951323	-1180552	-162046.4**	231467.7***
	(837816.1)	(45125.87)	(58308.7)	(3673152)	(853723)	(45892.0)	(59106.1)
VIF	1.24	1.30	1.18	1.37	1.25	1.35	1.21
Observations	178	102	130	48	178	102	130
BM/CW Test	0.0000***	0.0000***	0.0050**	0.0000***	0.0000***	0.0000***	0.0056**
Adj. R^2	0.7342	0.3448	0.5840	0.7809	0.7359	0.3449	0.5846
F-Test	3.81***	5.02***	27.16***	2.54*	3.43***	4.52***	24.32***
Ramsey-Reset Test	0.0000***	0.0462*	0.0859	0.0000***	0.0000***	0.0508	0.0936
	Chow-Test Structural Change all vs<20000 & >20000: F=5.23***				Chow-Test Structural Change all vs<20000 & >20000: F=4.57***		

Notes: Standard Errors in parentheses. *** p<0.001; ** p<0.01; * p<0.05

Table 6. Population, Waste Volume, Change in Tons/Inhabitant and in Selective Collection

	1. Cooperating (2000=67; 2019=82)	2. NonCoop (2000=111; 2019=96)	3. Decoop (C. 2000, S.A. 2019) (n=7)	4. Incoop (S.A. 2000, C. 2019) (n=22)	5. Permanent Coop (n=60)	6. Never Coop (n=89)
Average Population 2000	4817	39610	4804	7394	4821	47573
Average Waste Volume (Tons) 2000	2407	20675	2564	4846	2389	24587
Tons/Inhabitant 2000	0.500	0.522	0.534	0.655	0.496	0.517
Average Population 2019	7317	52204	6434	10475	6158	55804
Average Waste Volume (Tons) 2019	3764	25059	3559	5988	2949	26751
Tons/Inhabitant 2019 (%)	0.514	0.489	0.553	0.572	0.479	0.479
Tons/Inhabitant change (%)	+2.8%	-6.3%	+3.6%	-13.7%	-3.4%	-7.4%
Selective collection change (%)	306%	292%	601%	612%	378%	255%

Online Appendix

Baseline survey

The baseline survey was completed by municipalities between May 2001 and October 2002. It initially included municipalities serving between 500 and 1000 inhabitants, but the response rate was too low for inclusion. Variables obtained included the service provider (municipality or an IMC), service producer (public or private), service frequency (collection days each week), service costs (see Bel & Costas, 2006). For year 2000, that sample represented 44.2% of municipalities over 1,000 inhabitants, and 78.9% of the Catalan population.

Timeline and methodology of the new survey.

The new survey was mailed in September 2020 to the 186 target municipalities, with email remainders in January and March 2021. Emails were then sent to municipal Mayors in April 2021 as necessary, followed by the full survey in May. In June 2021 we extended the request to those county councils and mancommunities (plus the metro-area of Barcelona) that could provide additional information to that so far obtained. By summer 2021, some 50 responses remained outstanding. In July 2021 formal requests were made using Spanish transparency legislation, with reminders sent in September. In November 2021, the *Comissió de Garantia del Dret d'Accés a la Informació Pública* (GAIP) issued a deadline for the remaining 20 municipalities and county councils to respond by January 2022. All data were available February 2022. Incorrect data was submitted in 12 cases, either because collection costs were incomplete or aggregated with treatment costs. We obtained corrected information for four of the 12.

Table SM1: representativeness of the sample (2019)

	Municipalities included in the analysis			
Inhabitants	1,000-9,999	10,000-10,999	≥ 20,000	Total ≥ 1,000
Municipalities	102	28	48	178
% Total Municipalities	30.1	50.9	72.7	38.9
Population	434,726	419,232	4,757,612	5,611,570
% Total Population	35.5	53.1	87.0	75.0
	Total municipalities (≥1,000 inhabitants) and population – 2019			
Inhabitants	1,000-9,999	10,000-19,999	≥ 20,000	Total ≥ 1,000
Municipalities	339	55	66	460
Population	1,224,647	789,005	5,468,797	7,482,449

Note: There are 487 municipalities with <1,000 inhabitants, totaling 192,768 inhabitants, which is about 2.5% of total population of Catalonia.
Source: Authors' survey, IDESCAT (Catalan Statistics Institute) and INE (Spanish Statistical Institute)

Table SM2. Results for the subsample of 2019 decomposing by type of IMC organisation

	(all, 2019) OLS	(pop<10,000, 2019) OLS	(pop<20,000, 2019) OLS Robust	(pop>20,000, 2019) OLS
Volume	0.9728***	0.8364***	0.8730***	1.0827
	(0.0371)	(0.0550)	(0.0463)	(0.0732)
Selective	0.3898***	0.4057***	0.3893***	0.4625
	(0.0824)	(0.0823)	(0.0960)	(0.3033)
Pop_Density	0.0093	0.0610	0.0292	0.0186
	(0.0268)	(0.0343)	(0.0320)	(0.0618)
Frequency	0.2308*	0.2295*	0.2716*	0.4376
	(0.1077)	(0.1063)	(0.1032)	(0.3843)
Tourism	0.0009	0.0274***	0.0126*	-0.0040
	(0.0021)	(0.0059)	(0.0060)	(0.0028)
WR_Facility	0.0021	0.0715	0.0599	0.0723
	(0.0642)	(0.0658)	(0.0580)	(0.1781)
Private	-0.0015	0.0254	0.0282	-0.0652
	(0.0592)	(0.0660)	(0.0659)	(0.1384)
Coop_County	0.0423	0.0901	0.0530	-0.0388
	(0.0590)	(0.0637)	(0,0641)	(0.1459)
Coop_Mancommunity	-0.1827†	-0.1626	-0.1876**	0.1216
	(0.1048)	(0.1198)	(0.0685)	(0.3017)
Constant	2.9002***	3.4332***	3.3397***	1.0820
	(0.4256)	(0.4972)	(0.4825)	(1.8344)
VIF	1.85	1.34	1.50	1.45
Observations	178	102	130	48
BM/CW Test	0.2340	0.4726	0.0340*	0.4764
Adj. R^2	0.9492	0.8658	0.9006	0.8724
F-Test	348.98***	65.96***	132.38***	36.70***
Ramsey-Reset Test	0.0274*	0.5787	0.1174	0.6192
Chow-Test Structural Change all 2019 versus <20000 and >20000: F=2.26* (p<0.025)				

Notes: Standard Errors in parentheses. *** p<0.001; ** p<0.01; * p<0.05; † p<0.10

Table SM3. Results with pairwise comparisons between different cooperative status (population < 20,000; most robust estimation, columns 19 and 23 in table 5)

	Early-Adopters	Followers (Incooperators)	Never-cooperators	
Early-Adopters	-	18025.9 (50111.7)	-186618.1** (53688.8)	
Followers (Incooperators)	-18025.9 (50111.7)	-	-204644.0** (62752.6)	
Never-cooperators	186618.1** (53688.8)	204644.0** (62752.6)	-	
	Permanent-cooperators	Followers (Incooperators)	Decooperators	Never-cooperators
Permanent-cooperators	-	24749.2 (52491.4	43587.0 (70024.1)	-181788.9** (55480.9)
Followers (Incooperators)	-24749.2 (52491.4)	-	18837.8 (74411.1)	-206538.0** (63081.2)
Decooperators	-43587.0 (70024.1)	-18837.8 (74411.1)	-	-225375.8** (77935.2)
Never-cooperators	-181788.9** (55480.9)	206538.0** (63081.2)	225375.8** (77935.2)	-

Note: 'Early Adopters' in the upper section of the table integrates the categories Permanent Cooperators + Decooperators in the lower section of the table.

Results correspond to the most robust estimations in table 5, those for municipalities < 20,000 inhabitants, columns 15 and 19). Note that comparisons between different cooperative status in all other estimations (columns 13, 14, 16, 17 and 18, not shown in table 5), are not significant.

Standard errors in parentheses; *** p<0.001, ** p<0.01, * p<0.05