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

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Abstract

Organizations develop collaborative relationships in order to manage external interdependencies that are consequential for performance. Econometric research has tested whether such collaboration brings improved performance among public service providers, often finding beneficial – albeit contingent – effects, but with significant unexplained variance in some results. Focusing on the case of inter-municipal cooperation, we investigate whether robustness and model fit can be improved by including variables related to time. Specifically, drawing on theories of environmental dynamism, organizational inertia, accountability "drift," and isomorphism, we examine how age of collaboration and timing of reform affect the financial performance of solid waste collection partnerships in the Spanish region of Catalonia over the period 2000-2019. We find that, though still present and significant, the cost advantages of intermunicipal cooperation decline over this period due to increased intra-municipal demand and, hence, reduced external interdependence. Timing of reform adoption has no effect on outcomes; although the attributes and policy objectives of early-adopter and follower groups differ.

JEL classification: H77, L38, R59.

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 the functioning of the organization and yet fall beyond the direct control of its 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 beyond the reach of single organizations (Andrews & Entwistle, 2013; 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 optimal performance comes from the "fitting" of structure to circumstances (Donaldson, 2001; Andrews et al., 2015), financial benefits have been shown to depend on the cost function of the shared activity, the size of the partnering organizations, and the ability to control opportunism among partners (Bel & Sebő, 2021), as well as accurately estimating the size of the external interdependence motivating the collaboration (Elston & Dixon, 2020). Yet findings remain somewhat inconsistent across studies, and models often contain much 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 age of the collaboration at the moment of evaluation, and the timing of reform vis-à-vis peer organizations – 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 structure to task and environmental 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 public service contracting have advocated a more dynamic approach, noting the evolution of both sourcing decisions and contracting 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 service performance.

Partnership age may affect performance through a variety of mechanisms. Initially, distance between inception and evaluation allows time for one-off reform costs to pass, experiential learning to accumulate, and greater familiarization (and possibly trust) to develop among partners (Yang, et al., 2009). However, longer-term, partnerships may become removed from the conditions prevalent or predicted at their founding – especially if environments are dynamic and organizational inertia (perhaps also correlated with age) restricts adaptation. Furthermore, with age, partnerships may become subject to less stringent accountability as collaborators gain "earned autonomy" once adequate performance is attained, or staff turnover reduces capacity for effective monitoring – again reducing performance.

As for reform timing, 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, which posit that managers pursue legitimacy as well as efficiency through their reform choices (Meyer & Rowan, 1977; Ashworth et al., 2009), provide an alternative basis for predicting differential performance among early and late collaborators. Specifically, isomorphic pressure generated after initial reform diffusion could provide markedly different motivations for, levels of commitment among, and degrees of contingency fit with 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 time could improve understanding of collaborative performance. We test this argument on two-wave panel data describing the relative performance 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 overtime as population growth weakens the interdependence between small (but growing) municipalities. Conversely, although the attributes and collaboration objectives of early- and late adopters differ, this does not translate to a performance effect, with equivalent cost advantages attained by first-movers and followers alike.

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 neighboring or non-neighboring 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 spillovers 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 can be attained 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. (2021); 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 service 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)). Most consensus has arisen around (i) the service's cost function and (ii) the volume of activity undertaken by individual municipalities in relation to this. Collaborative efficiency requires services be subject to economies of scale (e.g., due to fixed costs), and that low municipal population be inhibiting the attainment of technical efficiency (Bel & Costas, 2006; Blaeschke & Haug, 2018). Niaounakis and Blank (2017), for instance, found that joint tax administration among municipalities in the Netherlands was efficient for cooperatives serving up to (but not over) 60,000 inhabitants, with the optimal size being around 10,000. Equally, Dixon and Elston (2019) found no such benefit among tax partnerships for district councils in England, for whom the average individual 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 have shown the beneficial effects of privatization to diminish over time (Bel & Costas, 2006; Dijkgraaf & Gradus, 2008; Bel et al., 2010; Petersen et al., 2018). But, in the case of IMC, only Aldag et al. (2020) explore whether performance is maintained, improved or eroded dynamically, and only as a post hoc analysis. Moreover, as far as we know, *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. Time between inception and evaluation

In "rational-instrumental" terms, according to which organizational decision-making is driven by the logic of consequences (Christensen et al., 2007), collaboration is intended to 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 subject to task interconnections or negative externalities, or with whom there is potential to generate scale economies. Organizational environments are both "textured" (that is, many-sided) and dynamic (Aldrich, 2008; Andrews et al., 2012), meaning that the manner and extent of environmental influence on performance can vary over time, perhaps considerably. In extremis, large changes 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 circumstances.

However, inertia may prevent such 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 collaborators develop "organizational and individual attachments to an exchange" (Ring & van de Ven, 1994, p.107). Organizational attachments, or "lock-in," owe to sunk costs, limited management capacity for identifying new partners or re-negotiating agreements, or lack of feasible alternatives. Individual attachments arise from inter-personal affective ties developing between staff from different partners, leading to the "maintaining [of] an exchange relationship that is providing fewer of the needed resources than it originally did, 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, p.8??), 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.” These founding “blueprints” restrict subsequent development, preventing 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 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). With multiple principals employing 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 councilors 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. However, past performance does not guarantee future success, especially in dynamic environments and if early successes were partly the result of learning and incentives provided by the initial accountability regime. Reduced oversight might, paradoxically, undermine subsequent performance, and detecting and correcting this decline may in turn be delayed by the reduced 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 newly-appointed "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, since lack of internal capacity prohibits in-sourcing (Lamothe, et al., 2008). Second is to further reduce monitoring, especially for complex services that require esoteric knowledge in order to interrogate performance (Grimshaw et al., 2002, p.495).

To summarize, then, the benefits of IMC service provision may diminish over time due to the evolution of organization-environmental interdependencies, inertia and imprinting slowing and/or restricting adaptation, and the multiple risks of accountability “drift.”

H1: Comparative advantage of IMC service provision diminishes over time (Hypothesis 1)

3b Timing of an IMC partnership formation

As well as partnership age, the timing of partnership formation may also explain collaborative performance. “First-mover” advantages and disadvantages are debated extensively in strategic management and industrial economics (Suarez & Lanzolla, 2005; Lieberman & Montgomery, 2013). Monopolizing of technological innovations through swift patenting and pre-emptive acquisition of critical assets are typically cited in support of first-mover advantage. 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 competition for resources as prima-facie reasons for investigating first-mover advantages in government.

However, the institutional theory of organizations provides an alternative basis for predicting differential performance among early and late participants in a public management reform trend, albeit based on markedly differing assumptions.

In contrast to the means-ends, "instrumental" rationality of mainstream management theory, institutionalists argue that demonstrating legitimacy to external stakeholders is a vital additional consideration for managers, 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 empirical studies of legitimacy-seeking explored the diffusion of reforms through organizational fields, positing differing intentions for those adopting the reform at either ends of the trajectory (Tolbert & Zucker, 1983). As Kennedy and Fiss (2009, p.897) summarize, such 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 could have profoundly dissimilar *motivations* for reform (problem solving, versus legitimacy seeking); *commitment* to reform (do what it takes to solve the problem, versus do the minimum needed to demonstrate institutional compliance); and degree of *contingency fit* between reform and local circumstances (design for specific problems, versus apply general practices regardless of local conditions). These differences may in turn translate to differences in collaborative performance depending on the timing of partnership adoption relative to peer organizations. In particular, if late-stage adopters adopt collaborative relations that are less driven by problem solving, make only superficial and symbolic changes to their routines and practices to accommodate the collaboration (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 conducive to up-scaling through IMC), followers may perform worse than first-movers:

H2: Late-stage IMC adopters tend towards worse performance than early-stage adopters (Hypothesis 2)

4. Geographical and institutional context

4a. Local government in Catalonia

Our study is conducted in 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 (see figure 1). County councils are formed according to the results of the municipal elections in the county's municipalities (indirect election), based on which political parties appoint their respective fraction of city county councilors. These elect the county's president, who appoints the members of the county's government among the county councilors. Counties exert powers delegated by the Catalan parliament, as well as managing a variety of municipal-level public services in cases where constituent municipalities voluntarily choose to delegate these functions upwards.

Figure 1. Counties in Catalonia

Over three decades, counties have become the predominant method of inter-municipal cooperation in Catalonia (as well as in the neighboring region of Aragon). Voluntary associations of municipalities ("*mancomunitats"*) that are jointly governed by members are also used, although to a lesser extent than in other regions where county councils do not exist (Bel et al., 2022a), and where other cooperative organizations and agreements are more widely used (Zafra-Gómez et al., 2013; Pérez-López et al., 2015).

4b. Waste management

Spanish law requires municipalities to provide waste management services (Law 1986), including both collection and transportation (hereafter: collection) and waste valorization (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 service (possibly using a private contractor) or inter-municipally – through either the counties or voluntary associations already described. For county-level provision, county governments determine mode of production: public, private or mixed. For voluntary associations, the participant municipalities jointly decide which mode of production to use.

5. Empirical strategy

5a Data and sources

We study the performance 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 (see Bel et al., 2022b). Consequently, we built the database as follows.

First, our baseline comes from the dataset used in Bel and Costas (2006),[1] 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. For that year, that sample represented 44.2% of municipalities over 1,000 inhabitants, and 78.9% of the Catalan population.

Second, we administered a new and equivalent survey specifically directed to those 186 municipalities for which information for 2000 was available. Our aim was to obtain data on waste collection costs and service characteristics for 2019, enabling a comparison over the space of two decades. Covid-19 delayed the start of data collection to September 2020 and lengthened the process due to the on-going burden of the pandemic on councils. But, since

[1] 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).

the observation year is 2019, Covid-19 disruption did not distort the data reported.[2] 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 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.[3] This represents 95.7% of the municipalities initially targeted. Table 1 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, where most municipalities have extremely low population.

[2] 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.

[3] 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 1: 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)

Within our dataset, the number of cooperating municipalities in 2019 is 82 (46.1% of total), higher than that in 2000, when 67 municipalities (37.6% of our sample) were cooperating. Cooperation is more frequent in smaller municipalities (68% below 10,000 inhabitants; 57% below 20,000 inhabitants) than in larger municipalities (17% above 20,000 inhabitants). Therefore, by weighting representativeness of municipalities in our database, frequency of cooperation would be close to 60%.[4]

5b. Variables and methods

We follow the methodology proposed in Stevens' (1978) seminal article, which has been commonly followed thereafter to analyse waste collection costs and production choices. Furthermore, we follow the cost function proposed in Bel and Costas (2006), which adds to

[4] Furthermore, if we consider that our database excludes municipalities below 1,000 inhabitants, frequency of cooperation in the region would well above 60%. Percentage of population provided waste collection by means of cooperation would be approaching 20%.

Stevens' variables by allowing analysis of the effect of provision choice.[5] This methodology is common in empirical studies on cooperation and costs (see Bel and Sebő (2021)). Our objective is to analyse the effect of IMC on waste collection costs, and how such effects evolved over two decades from 2000 to 2019. Our dependent variable, annual service expenditure inclusive of employee, capital and overhead costs, 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, and 0 otherwise.

Private production (Priv). Production choices may influence costs. IMC (a form of *provision*) is compatible both with public and with private *production*. PRIV is a dummy variable that takes value 1 when service delivery is by private firm(s),[6] 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.

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[5] 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.

[6] 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.

Percentage of selected waste (PcSel). Waste recycling has been intensively 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).

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 kilometer. Empirical literature provides on this is mixed. 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 2 summarizes our variables and sources.

Table 2: 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)

5c. Methodology

To test whether cooperative provision affected performances, and the dynamics of that effect, we specify the following type of model for waste collection costs incurred by municipalities:

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

The tourist index is a continuous variable yet contains observations with value 0, meaning that it cannot be logarithmically transformed. From here we follow the standard approach proposed in Stevens (1978) and further developed in Bel and Costas (2006), and we 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 3. The correlation matrix is provided in the supplementary materials.

Table 3. 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

Turning now to statistical issues, we conduct robust estimations to control for heteroskedasticity when advised by the Breusch-Pagan/Cook-Weisberg test. The average Variance Inflation Factor (VIF) is 1.97, and all single variables have an individual VIF below 4. Therefore, we do not have 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. We controlled for time effects by including a year dummy (which takes value 1 for 2019, and value 0, otherwise).

Studies indicate that issues existed regarding dimensions of municipalities and volume of waste, and scale economies (Stevens, 1978; Dubin and Navarro, 1988). In fact, Bel and Costas (2006, p. 13) 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

Table 4 presents the results from the estimations for our full sample (2000 and 2019 combined), and for the population-defined subsamples above explained. We also include the OLS clustered estimation for the whole sample to facilitate comparison of results with estimations for the subsamples. All estimations are robust, and results for the Ramsey Reset test ($p>0.05$) do allow for rejecting the hypothesis of not missing significant variables in the model. 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=0.098). Nor are other control variables such as population density, facilities, and private delivery significant.

Table 4: Results for the complete sample (2000 and 2019)

	Column 1 (all) GLS Random	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
Adj. 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

Columns 2 to 4 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 is different depending on the population of municipalities (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.

In all, our results show that Cooperation is associated with lower costs for less populated municipalities, which collect lower volumes of waste. Coefficients for waste volume from the estimations of municipalities below 10,000 and below 20,000 indicate positive economies of scale (significant at 5% level), whereas economies of scale are not statistically significant for the full sample, nor for municipalities above 20,000 inhabitants.[7]

Turning to evidence on dynamic effects (Hypothesis 1), lower costs for cooperation, while strongly significant for smaller municipalities in our full sample (columns 2 and 3), 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 5 (in this estimation we use the original

[7] The correlation matrix shows that the variable *PopDens* has a correlation of 0.816 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).

current costs, in euros of 2000). 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 robust, the Ramsey Reset test results indicate that there are not significant variables missing in the model, and explanatory capacity is very high.

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 (column 5), different from our results for the complete sample (columns 1 and 1b in table 4). 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 6) and 20,000 inhabitants (column 7). This suggests that cost saving effects from cooperation have diminished through the two last decades. (Results for municipalities above 20,000 inhabitants (column 8) are identical to those obtained for the whole 2000-2019 sample (column 4, in table 4), as the coefficient is not significant.) Furthermore, if we estimate our model only for 2019 data 2019 (columns 9 to 12 in table 5), cooperation does not show any significant relationship with costs, - either for the estimation with all municipalities (column 9), or for smaller municipalities (columns 10 and 11). 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.

Table 5. Results for the subsamples of year 2000 and of year 2019

	Column 5 (all, 2000) OLS	Column 6 (pop<10,000, 2000) OLS	Column 7 (pop<20,000, 2000) OLS	Column 8 (pop>20,000, 2000) OLS	Column 9 (all, 2019) OLS	Column 10 (pop<10,000, 2019) OLS	Column 11 (pop<20,000, 2019) OLS	Column 12 (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

Turning now to the effect of reform timing on financial performance (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%) between 2000 and 2019. This involved 22 municipalities joining IMCs post-2000 ("late adopters"), and seven municipalities terminating their arrangements ("decooperators"), producing the net addition of 15 cases. Sixty municipalities cooperated continually across 2000-2019 ("permanent cooperators"), 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 delivery, 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*.

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

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 6 present the results. Estimations for municipalities above 20,000 are identical, as decooperaators do not exist in this segment (therefore, we omit column 16 for the sake of simplicity, as it would be equivalent to column 12).

Table 6. Estimation for changes in costs between 2000 and 2019 (costs in euros of 2019)

	Column 13 (all) OLS robust	Column 14 (pop<10000) OLS robust	Column15 (pop<20000) OLS robust	Column 16 (pop>20000) OLS robust	Column 17 (all) OLS robust	Column 18 (pop<10000) OLS robust	Column 19 (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 (89032.1)	13364.7	1571.5	294.3
	(10378.7)	(806.8)	(1226.5)		(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

As in all cases above, estimations are robust, and explanatory power is still reasonably high, although somewhat 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 15, that for municipalities below <20,000, for which the Ramsey Test does not reject that no omitted variables exist). 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 6, 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 15). (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 6 (corresponding to the most robust estimations in tables 6, 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 6), are not significant.

Table 7. Results with pairwise comparisons between different cooperative status (population < 20,000; most robust estimation, columns 15 and 19)

	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

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

7. Discussion

Based on theories of environmental dynamism, inertia, and accountability drift, we hypothesized that the comparative advantage of IMC provision may 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). Existing evidence on cost trajectories of IMCs is limited and inconsistent. In a multi-service study of IMC in New York state, Aldag et al (2020) found that five out of twelve services achieved collaborative costs savings, and all five retained cost advantages after 20 years. Three of these (police, libraries, and roads) actually increasing savings. Conversely, sewer services saw decreasing savings, while savings for waste collection followed a very volatile path.

Our results, based in a single service but with a more comprehensive modelling, confirm the "rusting" hypothesis in the case of waste management. Cooperative provision in Catalonia is associated with lower costs than stand-alone provision, but this effect is only significant for the municipalities of lower population, and the significance and dimension of the cost-advantage diminished between 2000 and 2019.

Of the several mechanisms potentially responsible for this, 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%). Those municipalities opting for cooperative provision in 2000 experienced far larger growth than the average, however – from 4,819 to 7,317 inhabitants (51.8%) and from 2,407 to 3,764 tones (56.4%) (see Table 7, rows 1-2). As such, the degree of scale diseconomy suffered by the collaborators in 2000 reduced markedly by 2019, which in turn reduced the extent of their mutual reliance to generate volume-based efficiencies (so-called “scale interdependence”; see Elston, et al. (2018).

As for the second relevant factor, inertia, while our data does not allow us to observe what incremental changes in management practices and governance arrangements IMCs adopted in response to this changed interdependence, we do have seven cases of the more radical step of 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 8, columns 3 and 5). While case numbers are small, this would indicate that inertia is not acting as a drag on environmental adaptation: reform reversal is concentrated among municipalities with more significantly reduced external interdependence. As for their performance, de-cooperating councils show lower costs in 2019, and also a lower increase in costs between 2000 and 2019, than those never cooperating across this period.

Regarding the potential “imprinting” of IMCs with their founding purpose and structure, a second dimension of environmental change during 2000-2019, after population growth, was increased government policies relating to environmental sustainability and recycling. Not only is such “selective collection” more costly to implement, but municipalities also require sufficient administrative capacity to manage reward schemes introduced by higher tiers of government to incentivize sustainability policies. So, have IMCs escaped their founding blueprints by reorientating 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-adopter municipalities joining IMCs after 2000 increased their percentage of selective collection by 46.9 percentage points – much higher than municipalities that never cooperated across 2000-2019, where selective collection grew by 31.5 percentage points (statistically significant at $p<0.01$). Finally, still within the domain of sustainability, late adopters decreased their waste/inhabitant ratios and increased selective collection more than any other group (see Table 8). Together, this indicates that late-adopters have placed the strongest emphasis on sustainability, reflective of the evolving regulatory environment over 2000-2019.. This would be consistent with the fact that we found a structural change for the models between 2000 and 2019, as indicated in table 5.

Lastly on Hypothesis 1, while this dataset does not provide information on whether accountability drift contributed to diminishing financial benefit of IMCs over time, prior research suggests that institutional arrangements in Catalonia – in particular, the prevalence of delegation to county councils (21 out of 25 cooperative agreements, involving 73 out of 82 cooperating municipalities) rather than to voluntary associations ("mancommunities") – reduces common agency problems, since this allows better aligning the interests of the governing board with those of the median principal (Voorn, et al., 2019; Bel & Sebő, 2021).

Table 8. 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%

Turning to Hypothesis 2, we suggested that differences in motivation for and commitment to collaboration might create different outcomes among first-movers and followers, building on the institutionalist view of organizational reform and the “two-stage” model of isomorphic diffusion. While collaboration is often described in purely “rational-instrumental” concerns, a growing body of research points to the symbolic, image-enhancing bases 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 performance 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 reform-fitness characteristics. Recall that IMC is most suited to smaller municipalities suffering most from scale diseconomies, and that legitimacy-seeking behavior is thought to predominate decision making 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 performance effect.

8. Conclusion

Amid a growing literature evaluating collaborative public management strategies (particularly regarding the financial effects of inter-municipal cooperation), as well as 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 and, ultimately, professional practice.

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 neighbors 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 very significantly between 2000 and 2019.

As for the timing of collaborative reform relative to peers, while we did not find evidence of an efficiency differential between early and late adopters, analysis of the attributes of early and late adopters indicates that the latter were "promising" rather than "prime" candidates for IMC, though this neither rules out nor confirms isomorphic pressures. Indeed, as institutional theorists have increasingly reiterated (Greenwood et al., 2008), legitimacy-driven organizational choices do not necessarily entail objective performance loss, and cannot be inferred solely from changes in reformer characteristics vis-à-vis peer organizations. As such, future research on dynamic effects in collaborative public management should employ longitudinal mixed-methods designs in order to secure qualitative evidence on reform motivations too.

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Appendix

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. corr lncorecbas2019cat lnvolum lndens lnfreq turrel Instal PrivadaMixtMaj Coop
(obs=356)
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	lncore~t	lnvolum	lndens	lnfreq	turrel	Instal	Privad~j	Coop
lncorecbas~t	1.0000							
lnvolum	0.9741	1.0000						
lndens	0.8066	0.8190	1.0000					
lnfreq	0.5314	0.5116	0.4330	1.0000				
turrel	0.1513	0.1519	0.0481	0.0254	1.0000			
Instal	0.2689	0.2659	0.1772	0.0151	0.1749	1.0000		
PrivadaMix~j	0.1843	0.2034	0.1839	0.0631	0.0485	0.0130	1.0000	
Coop	-0.5204	-0.5311	-0.4949	-0.3051	-0.0809	-0.0817	-0.3589	1.0000

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