



Mechanism Design in Regional Arrangements for Water Governance

RESEARCH ARTICLE

TOMÁS OLIVIER 

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ABSTRACT

Governing shared water resources requires collaboration among multiple actors, often attained through formal or informal institutions. This paper analyzes how governments design institutions to address common challenges for collective action. More specifically, the paper asks whether variations in levels of transaction cost risk influence the design of formal mechanisms for monitoring, ensuring compliance, or sanctioning noncompliant behavior in the governance of shared water resources. To that end, four intergovernmental agreements for securing access to unfiltered drinking water in the United States are studied: in Boston, New York, Portland, and San Francisco. Results indicate that transaction cost risk may play a role in the design of monitoring and sanctioning mechanisms, but that variations in design are more nuanced than originally anticipated. Also, the analysis highlights the existence of common design strategies for addressing conflict, regardless of the levels of transaction cost risks.

CORRESPONDING AUTHOR:

Tomás Olivier

Florida Atlantic University, US

oliviert@fau.edu

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INTRODUCTION

Institutional arrangements provide mechanisms to address collective problems. Such problems are common in the governance of natural resources, where resources cross multiple jurisdictions and multiple actors are involved. In past decades, studies within the Common-Pool Resource (CPR) literature have identified a series of design principles present in successful cases of long-standing CPR governance (Ostrom, 1990, 2005). However, at medium and large scales, the literature still debates the characteristics of those design features for addressing collective action (Heikkilä et al., 2011; Fleischman et al., 2014). At these scales, multiple actors might possess authority over a resource that crosses political, geographical, or organizational borders, creating interdependencies and the need for collaboration among decision-makers.

Addressing collective action problems at these scales requires of institutions that create linkages (Heikkilä et al., 2011) among decision-makers. The design of said linkages must take into consideration things such as the nature of the problem, actor preferences, and existing institutions (Kim et al., 2020).

This paper builds on insights from transaction cost approaches to understand how institutional arrangements created by governments to manage shared water resources are designed in the face of different transaction cost risks. In particular, the paper asks, do governments rely on similar types of monitoring, compliance, and enforcement mechanisms when facing different levels of transaction cost risks?

The cases relate to the governance of sources of unfiltered drinking water in New York City (New York), Boston (Massachusetts), Portland (Oregon), and San Francisco (California). In these four cities, drinking water is obtained from surface water sources outside city limits. To maintain compliance with federal regulations, providers must develop formal arrangements with landowners (either federal, state, or local governments) to tap into that water and protect quality at the source. Failure to do so would result in mandates to filter drinking water, which is prohibitively costly when compared to the strategies in place (Kavanaugh, 1999; Pires, 2004).

Interviews and secondary sources are used to assess levels of transaction cost risks faced in each case prior to developing their formal arrangement. Interviews are followed by an analysis of the formal documents creating each arrangement, identifying rules defining mechanisms for monitoring, compliance, and sanctioning of noncompliant behavior. Findings show that variations in transaction cost risk are associated with different designs of mechanisms for monitoring and for sanctioning

noncompliant behavior. However, higher relative transaction cost risks are not necessarily associated with more and varied tools for monitoring and sanctioning, and their influence on mechanism design may depend on whether rules are aimed at monitoring or sanctioning behavior.

The rest of the manuscript is structured as follows. First, arguments from studies applying transaction cost approaches to environmental governance are discussed to develop an overarching expectation about the role of transaction cost risk in institutional design. Second, the cases will be introduced, showcasing the importance of the institutional arrangements studied to secure high-quality drinking water for the cities studied. Third, the data and methods will be presented, followed by a results section. Finally, the manuscript ends with a discussion of the results and a conclusion highlighting limitations and avenues for future research.

TRANSACTION COSTS RISKS AND INSTITUTIONAL DESIGN

The literature on New Institutional Economics has long argued that institutional design is largely a function of the context in which those decisions take place (McCann, 2013). Embedded in this literature, arguments from Transaction Cost Economics (Williamson, 1981, 1996) have been extended to understand issues of collaboration regarding common pool resource governance (Ostrom, 1990), government contracting (Brown & Potoski, 2003a, 2003b), among others. Studies in political science and public policy have relied on insights from transaction cost economics to explain the decisions governments make when engaging in collective action with other governments and their choices regarding which institutional mechanisms to use for doing so (see, for instance Brown & Potoski, 2003b; Koremenos, 2016; Oakerson, 1999). For these approaches, design choices will be determined by whether the benefits of designing and maintaining an arrangement outweigh its costs. Recent empirical literature has either focused on the choices governments make regarding the integration of their joint activities (Hansen et al., 2020; Kim et al., 2020) or on mechanism design at the international level (Koremenos, 2016; Koremenos et al., 2001). Within these, multiple studies have analyzed cases of environmental policy (for example, Coggan et al., 2010; McCann, 2013; McCann et al., 2005) and water policy (such as, Colby, 1990; Garrick & Aylward, 2012; Grolleau & McCann, 2012; Lund, 1993). Although applied in different contexts, the logic of the argument is the same: as parties to an agreement face increased levels of transaction cost risks, the transaction costs they face will increase, and thus the institutions they design will tend to be more complete or elaborate.

With some exceptions (Koremenos, 2016; Koremenos et al., 2001), this literature has largely focused on the broad choices that governments make in designing policies and institutional arrangements, arguing that “the desired level of [institutional or policy] specificity is one in which the contracting party trades off between the costs of specifying more contingencies and the gains from safeguarding against potential problems” (Mooi & Ghosh, 2010, p. 107). However, an important question remains of whether and how differences in transaction risks shape the design of the specific mechanisms used to anticipate such problems.

In a broad sense, transaction costs are the costs of arranging and designing a contract, as well as the costs of monitoring and enforcing it (Matthews, 1986). These costs can be disaggregated in two. On one hand, there are costs that occur *ex ante* a transaction or policy decision is made, which include costs of gathering information and bargaining mutually acceptable solutions. *Ex posts* costs, on the other hand, are the costs associated with enforcing the agreed-upon rules (Mooi & Ghosh, 2010), such as the costs of monitoring or costs associated with rule misinterpretation. Actors involved in a transaction must balance the costs of designing highly specific arrangements with the costs of following through and enforcing them. The extent to which a set of actors are willing to spend resources in addressing such transaction costs will be largely determined by a series of contextual factors.

Transaction costs can be influenced by a variety of risk factors, such as aspects related to the transaction (asset specificity, the frequency and timing of transactions, and general uncertainties about the transaction) and actor-related factors (bounded rationality and opportunism) (Coggan et al., 2010). Current institutional arrangements can also shape actors preferences and behaviors, as well as additional actor characteristics such as trust, shared ideologies, or social connectedness (Coggan et al., 2010).

However, not all risk factors will always play a role in influencing transaction costs. In their study of watershed services programs in Munich and New York, Grolleau and McCann (2012) identify four of such factors: the history and institutional relations among the parties involved, the number of actors negotiating these agreements, the time needed to research and devise an agreement, and the visibility of the problem. For the most part, these risk factors exist prior to any action and are the reason why parties to an agreement will invest in designing and maintaining mechanisms to mitigate these risks and thus achieve the goals of their collaboration.

One of the key tenets in the transaction cost literature is that institutional arrangements will incorporate safeguards to protect the parties against opportunism and sustain collective action. These safeguards generally assume

three forms: establish penalties, provide mechanisms for in-house conflict resolution, and embed participants in redundant forms of interaction to facilitate reciprocity (Williamson, 1996, p. 62). Similar safeguards have been also identified as important in other literatures within the neo-institutional realm. The literature on common pool resources (CPR), for instance, has long identified a series of institutional features that are associated with successful collective action in CPR governance (Ostrom, 1990; Cox et al., 2010). Most of the research that followed has focused on CPRs at small and medium scale, where users (and parties in these self-governing arrangements) are individuals. At larger scales, however, other actors and dynamics become relevant (Cash & Moser, 2000; Berkes, 2002; Dietz et al., 2003; Young, 2002, 2006; Fleischman et al., 2014; Epstein et al., 2014), which may require different rule designs to maintain collective action. At large scales, Dietz et al (2003) point to four important issues when developing adaptable governing arrangements at larger scales: the provision of information, dealing with conflict, inducing rule compliance, providing infrastructure, and be prepared for change.

This paper focuses on three mechanisms commonly used to facilitate collective action: monitoring, compliance, and consequences. Actors designing governing arrangements have available a wide array of tools to monitor, punish, and address compliance issues (Koremenos, 2016). In the case of monitoring, institutions must facilitate the provision of information about natural processes as well as their interaction with human behavior. Governing a natural resource that is shared by multiple jurisdictions requires ensuring that the parties are engaged in rule-abiding behavior (Ostrom, 1990). One of the key monitoring decisions is whether an external member will be hired to conducting the monitoring (Koremenos, 2016). Additionally, monitoring clauses can refer to how the information used for monitoring will be collected, indicating whether monitoring will rely on self-reports or whether an organization will be granted authority to collect their own data. When actors face low levels of transaction costs risks, investing in redundant and resource-intensive mechanisms may result counterproductive, utilizing resources that could be spent differently.

If the purpose of an institutional arrangement is to sustain collaboration over time, it is important to be prepared to address differences regarding rule interpretation (Ostrom, 1990, 2005). Compliance mechanisms provide ways for deciding whether someone’s behavior was rule compliant or not and define how to address differences regarding rule interpretation. Access to local instances to address conflict can help solve differences in ways that will not jeopardize the maintenance of rule-abiding behavior (Ostrom, 1990).

Also, compliance mechanisms become important when actors have multiple and diverse preferences, which tend to increase the probability of conflict (Libecap, 1989).

Finally, whenever a party to an intergovernmental agreement breaks the rules, actors face a series of alternatives: devising new mechanisms allowing them to impose sanctions, resorting to sanctions from higher-order venues (i.e. Courts), or exiting the agreement. The first alternative requires investing in agreement-specific mechanisms or actors in charge of enforcing the rules. When the scope of an agreement increases, sanctioning noncompliant behavior becomes important to avoid conflict escalation. Also, in these agreements, sanctioning mechanisms need to vary in accordance with the different types of activities to be conducted. The second alternative requires fewer investments, but the costs come in the form of the time it may take a Court to decide. Finally, actors may leave the agreement. In some circumstances, the threat of abandoning the agreement may be enough to put other actors back in line (Bednar, 2008). This manuscript focuses on how and when formal institutional arrangements design the first two options.

The overarching expectation in this manuscript is that the choice of safeguard design will be influenced by the transaction cost risks faced by those involved in the arrangement. More specifically, settings facing higher levels of transaction costs risks should present more and varied types of mechanisms to address monitoring, compliance, and rule enforcement.

THE CASES: INSTITUTIONAL ARRANGEMENTS FOR THE MAINTENANCE OF WATER QUALITY IN BOSTON, NEW YORK, PORTLAND, AND SAN FRANCISCO

Unlike most U.S. cities, water providers in Boston (Massachusetts), New York (New York), Portland (Oregon), and San Francisco (California) provide unfiltered drinking water from surface sources (i.e. rivers, streams, and lakes).¹ Federal legislation in these cases require water providers to develop formal agreements with the landowners where the water is sourced, showing that the water provider has access and control over the land in order to ensure water quality protection at the source.

In 1989, concerned with levels of *Giardia lamblia* parasites and legionella bacteria in public systems, the U.S. Environmental Protection Agency (U.S. EPA) issued the Surface Water Treatment Rule (SWTR), tightening regulations for public water systems using surface water or

ground water under the direct influence of surface water. The SWTR requires water providers to filter their water while allowing a provider to waive this obligation if they can comply with water quality and site-specific criteria. Within the site-specific criteria, the SWTR establishes that “The public water system must demonstrate through ownership or written agreements with landowners in the watershed, or a combination of both, that it controls all human activities which may have an effect on the microbiological quality of the source water” (Surface Water Treatment Rule, 1989).

The four cities studied provide water from unfiltered systems and have developed formal arrangements with the owners of the land where their source their drinking water. However, these arrangements are not all the same. In addition to geographic and historical variation, the cases also vary in the number and types of actors participating in their agreements. In Boston and New York, resources are located on land owned by small towns and municipalities. On the other hand, Portland and San Francisco involve bipartite agreements between a city and a Federal Agency (Forest Service in Portland and the National Park Service in San Francisco), given that the water is sourced from federal lands. In addition, relationships between the parties prior to creating these arrangements varies by case.

DATA AND METHODS

To identify the characteristics of transaction costs risks in each case, 23 semi-structured interviews were conducted over the phone with key actors in each setting.² Interviews were conducted by the author between the months of March and August of 2016. Interviews lasted 71:40 minutes on average, and helped identify perceptions of transaction costs risks faced prior to the development of these arrangements, as well as providing a qualitative assessment of how monitoring, compliance, and consequence actions are applied in each case. Respondents were identified based on mentions in formal documents and via snowball questions. Appendix A list interview questions used to assess the history of relationship between the parties, as well as perceptions about the agreement.

The rules that constitute the governing arrangement in each case were coded to identify the presence and design of monitoring, compliance, and consequence mechanisms. The documents laying out the foundation of each institutional arrangement were identified by analyzing secondary sources and then corroborated by interviewees. **Table 1** lists the documents coded in each case.³ Building on existing approaches (Hanlon et al., 2019; Schlager et al., 2021), the coding process involved two steps: First, each document was coded applying the Institutional

FORMAL RULES CODED	
Boston	1992 (2003) Watershed Protection Act, 2004 Memorandum of Understanding, 2004 Watershed Protection Supply Trust Act, and 2011 DCR Regulations (350 CMR 11.00) ⁴
New York	1997 Memorandum of Agreement, 2010 NYC Rules and Regulations, 2014 Water Supply permit
Portland	1977 PL 95–200 Bull Run Act (modified in 1996 and in 2001), 2007 Agreement between Portland Water Bureau and U.S. Forest Service, Portland City Ordinance 21.36
San Francisco	1913 Raker Act, Department of the Interior Stipulations from years 1961/1985/1987, 2010 Memorandum of Agreement between San Francisco Public Utilities Commission and National Park Service

Table 1 Formal Rules in each case.

Grammar Tool (Basurto et al., 2010; Crawford & Ostrom, 1995, 2005; Siddiki et al., 2011). This approach allowed identifying the institutional statements that comprise each arrangement. Documents from Boston, Portland, and San Francisco were coded by the author and a second coder was assigned a random sample of statements to code. Intercoder reliability was assessed as the percentage agreement across IGT components between coders. The average percentage agreement in Boston was 80.4%, in San Francisco was 74.57%, and 81.36% in Portland. In New York, documents were coded by a team of three coders. Each coder was assigned an entire document section to code, and reliability coefficients were obtained by assigning a random sample of statements to the coders who did not code the section. Average percentage of agreement in New York was 84%.

The second step builds on the IGT for capturing groups of institutional statements creating mechanisms for monitoring, compliance, or consequences. A mechanism is a group of 1 to *n* institutional statements that prescribe, altogether, procedures for monitoring behavior or a biophysical condition, address compliance issues, or establishes consequences for noncompliant behavior (for a detailed description, see Brady et al., 2018). To identify mechanisms, institutional statements were grouped according to the sections of the documents in which they appear. Sections in a document were used to determine the beginning and ending of a mechanism. Within a section, each statement was coded based on whether it referred to *monitoring*, *compliance*, or *consequence* activities. If all statements within a section were coded as, for example, monitoring, that entire section would comprise a monitoring mechanism. However, sections can include more than one mechanism. In fact, a section can include several consecutive mechanisms. Sequences interrupted by two or more statements coded both as the same mechanism type (different from the one in the sequence), were considered as a new mechanism within that section.⁵

Data from Boston, Portland, and San Francisco was coded by the author, and a second coder was given a

random sample of approximately 20% of the statements in each document. Average percentage agreement between both coders was 78% for Boston, 77.8% for Portland, and 74% for San Francisco. Data from New York was coded by three coders. Each coder was assigned an entire document to code and the other two coders were assigned 20% of statements from the documents they did not code to assess intercoder reliability. The average rate of agreement in New York was 85%. Data obtained from coding each document was aggregated into a database with the mechanism as the unit of analysis, resulting in 357 observations. **Table 2** shows the number of mechanisms identified in each case.

To compare mechanisms across cases, a typology of monitoring, conflict resolution, and consequence mechanisms was created by analyzing each mechanism to identify emerging themes. This inductive approach allowed identifying four subtypes of monitoring (Individual action, joint work, generate information/conduct study, and water quality/quantity reports), five types of compliance (third party, definition, in-house, individual party, and venue), and six types of consequence mechanisms (easement restrictions, administrative actions, compensation, modify obligations, define rules that apply, consequences for individuals). Appendix C describes each type of mechanism.

RESULTS

The results section is divided in two. First, data from interviews and secondary sources is used to define the levels of transaction cost risk in each case. Then, the monitoring, compliance, and consequence mechanisms are compared to assess for differences between cases with different levels of transaction cost risks.

PORTLAND AND SAN FRANCISCO: BILATERAL AGREEMENTS BASED ON SHARED GOALS

Portland and San Francisco source their water from federally owned lands. Portland obtains it from the Bull Run watershed in Mt. Hood National Forest, managed by the

	BOSTON	NEW YORK	PORTLAND	SAN FRANCISCO
Monitoring	23 (62.2%)	95 (34.4%)	7 (36.8%)	17 (68.0%)
Compliance	10 (27.0%)	128 (46.4%)	10 (52.6%)	3 (12.0%)
Consequence	4 (10.8%)	53 (19.2%)	2 (10.5%)	5 (20.0%)
TOTAL	37	276	19	25

Table 2 Number of mechanisms.

U.S. Forest Service, whereas San Francisco does it from the Hetch Hetchy reservoir in Yosemite National Park.

In San Francisco, the history of Hetch Hetchy is marked by a divided public opinion on whether tapping into those resources was an act of encroachment or a necessary evil to ensure the growth of the City (Righter, 2005; Simpson, 2005). This degree of polarization, however, was never present in interactions between the City and the National Park. A City representative mentioned that before signing the first agreement (in 2005), “we [the City and the Park Service] had the same overarching objectives in the watershed [...] there weren’t many conflicting challenges or goals that one part had over another. We are dealing with the Park Service, their goal isn’t mining or drilling or anything like that” (SFPUC Representative, Personal Communication, May 2, 2016). A Park Service representative also shared this sentiment, indicating that both parties strive for the protection of the resource, although perhaps for different reasons (Yosemite National Park Representative, Personal Communication, April 12, 2016). The only differences between the parties occurred over the distribution of funding early on in their relationship. (SFPUC representative, Personal Communication, May 2, 2016)

In Portland, there were times when the City and Forest Service had disagreements. In the early 20th Century, Congress recognized Bull Run as a source of drinking water for Portland. However, the Forest Service had also a mandate to allow for timber extraction in the area, which affected water quality (Larson, 2009; Short, 2011). These disagreements halted in 1996 when Congress mandated stricter logging prohibitions in the watershed. Since then, both the City and Forest Service have enjoyed a good working relationship. Several interviewees defined this as a “pre and post logging relationship” (PWB Representative, Personal Communication, June 13, 2016) characterized by a “mismatch in agendas” (USFS Mt. Hood Representative, Personal Communication, June 22, 2016). The prohibition of timber extraction in the watershed limited the sources of income for the Forest Service in the area, thus making Mt. Hood even more dependent on the City (PWB Representative, Personal Communication, June 8, 2016), further aligning both organizations’ goals.

The number and goals of the parties also played a role. Since ownership of Bull Run and Hetch Hetchy is held by a single actor and public access to these lands is limited, watershed protection activities are focused mostly on controlling biophysical indicators. In San Francisco, the arrangements provide a framework for the City to fund activities implemented by the Park Service; “the agreements [...] are also a funding authority that allows us to provide the funding and the resources to the Park Service, to provide that service. [...] We’re really lucky in this case that we have primarily one entity that is responsible for how the land is managed, which is the Park Service” (SFPUC Representative, Personal Communication, April 11, 2016), “the City is helping provide funding to the Park Service to do that watershed protection we have agreed” (Yosemite National Park Representative, Personal Communication, March 24, 2016). In Portland, the situation is similar, with the agreement providing a funding and administrative framework. As stated by a City representative, “the purpose of the agreement was to deal with this [Forest Service’s] budget constraint and this staffing constraint by just giving each other a little bit more freedom to do the things we were responsible for” (PWB Representative, Personal Communication, June 8, 2016).

In sum, the existence of only one major landowner with similar goals reduces the transaction cost risks of developing and maintaining a partnership in both cases. For instance, in San Francisco, since the goal of the National Park Service is to protect the quality of the natural resources in the area, the Park does not have to go out of its way to conduct watershed protection activities. The same occurs in Portland, where after the Northwest Forest Plan and subsequent federal legislation, the U.S. Forest Service’s role became limited to protecting resources for maintaining water quality.

BOSTON AND NEW YORK: SIMILAR ISSUE, DIFFERENT ACTORS

Unlike San Francisco and Portland, both Boston and New York source their water from watersheds that are largely open to the public and located on land owned by other local governments or private individuals. As a result, the number of potentially affected actors and interests is larger.

In Boston, two state agencies manage three watersheds (Quabbin, Wachusett, and Ware) that supply the Boston metropolitan area. One of these agencies, the Massachusetts Water Resource Authority (MWRA) is a public authority in charge of providing wholesale water and sewer services to the metropolitan area. The other agency is the Massachusetts Department of Conservation and Recreation (DCR), in charge of implementing watershed protection measures. Both agencies share a common institutional past, as they came to assume responsibilities (at different times) from a previous organization, the Metropolitan District Commission (MDC) (Roberts, 1990). In 2004, DCR and MWRA signed a memorandum of understanding to define their watershed protection responsibilities.

In this arrangement, DCR designs and implements watershed protection plans, purchases land, and enforces regulations, all with funding from MWRA and overseen by a Board of Trustees composed of representatives from the State, MWRA, MWRA's Advisory Committee, and individual users. In this setting, watershed communities are not directly involved in decisions regarding watershed protection. *"Towns get money called Payments in Lieu of Taxes, or PILOT payments that come through the MWRA for facilities or land that was acquired for the water system. But they [watershed communities] don't have a formal relationship. [...] The towns are not required to listen, but they [watershed communities] can't ignore them [DCR] either, because they benefit from this management"* (MWRA Advisory Committee representative. Personal communication, August 15, 2016). Although the communities have had their differences with representatives from Boston, conflicts between them never reached high levels like in the case of New York (Steinberg & Clark, 1999).

The institutional past shared by DCR and MWRA naturally aligned their goals. However, differences emerged between agencies during the early years of MWRA (Roberts, 1990). After the division into two agencies *"there were a bunch of things which were not perfectly clear in the legislation [...] like, 'who is in charge of this, or who is in charge of that'"* (MWRA representative. Personal communication, June 3, 2016). Those differences were the ones that required the creation of agreements between both agencies. But in general, *"when it comes to issues of water quality and protection and so on, we [DCR and MWRA] work very much as a team"* (MWRA representative. Personal communication, June 3, 2016).

New York's case is famous for the long and conflictive history between New York City and the communities located on the watersheds from where the City obtains its drinking water (Finnegan, 1997; Soll, 2013; Galusha, 2016; Rueb, 2016). The conflict originated in the unilateral

actions the City had been conducting for over a century in the watersheds, during which the City *"kind of just did what we thought we needed to do around the water supply system without giving a great deal of thought to how the communities would feel about that"* (NYC Department of Environmental Protection representative. Personal communication. July 7, 2016). In the late 1990s, and to gain support from the over 70 watershed communities that comprise the watersheds (National Research Council, 2000), the City, watershed communities, the State of New York, the U.S. Environmental Protection Agency, and other nongovernmental organizations signed a governing arrangement to manage the watersheds. The agreement defined a mechanism for the City to acquire parcels of land from willing buyers in the watershed and created additional programs funded by the City. These programs are managed by a decision-making venue created by the agreement, the Catskill Watershed Corporation (CWC). Through these programs, the City compensates for the lost costs (in terms of tax revenue and productive use of the land) faced by the communities for selling parcels of land to the City. These programs focus on issues of economic development, infrastructure development, education, and overall improving the relationship between the City and watershed communities.

Boston and New York share similar features. Both rely on larger watersheds occupied by local governments and private actors. Because of this, their institutional arrangements encompass a broader array of activities than San Francisco or Portland. However, differences in the contexts of each case indicate different levels of transaction costs risks. In Boston, the agreement between DCR and MWRA resembles the bilateral agreements of Portland and San Francisco. In addition, the entire governing arrangement in Boston is based on State legislation that defines responsibilities for both agencies and establishes development restrictions in different sections throughout the watersheds (M.G.L. 92 A1/2). State laws impose responsibilities to MWRA and DCR but do not require a vote from watershed communities regarding watershed protection activities.⁶ In consequence, the actors formally involved are fewer than in New York and with similar goals. In New York, on the other hand, not only the agreement involves the City along with over 70 towns and villages, but also includes Federal (the U.S. Environmental Protection Agency) and State organizations (Department of Health and Department of Environmental Conservation).

In sum, New York presents higher levels of transaction costs risks among the four cases, followed by Boston. The extent and complexity of the land to be managed, the amount of people living in it, and the history of coordination issues between MWRA and DCR would indicate that Boston

presents higher relative levels of transaction costs risks than Portland or San Francisco. Finally, the presence of some disagreements between the City of Portland and the Forest Service earlier in their relationship indicates that this case showed higher levels of transaction costs risks than San Francisco.

MECHANISM DESIGN FOR WATERSHED PROTECTION

Table 3 shows the distribution of mechanisms types across the four cases. New York immediately stands out by the sheer amount of monitoring, compliance, and consequence mechanisms. The remaining cases show relatively similar amounts of mechanisms, with Boston having slightly more than Portland and San Francisco.

To compare the design of monitoring, compliance, and consequence mechanisms across the four cases, differences in the amounts of mechanisms were assessed using Fisher's exact tests. The comparisons were carried out using the R package compareGroups (Subirana et al., 2014). Table 4 presents p-values for the bivariate comparisons on the types of monitoring, compliance, and consequence mechanisms between pairs of cities.

Results show statistically significant differences in the design of monitoring and consequence mechanisms across cases. In the case of monitoring, all statistically significant differences are with respect with New York. Boston and San Francisco differ from New York ($p = 0.052$), but not Portland. Regarding consequences, New York differs from Boston ($p = 0.001$) and Portland ($p = 0.002$), but not San Francisco. Additionally, Boston's consequence mechanisms show statistically significant differences with San Francisco ($p = 0.095$).

The qualitative evidence also highlights the role of transaction costs risks in mechanism design. In Portland, when discussing how monitoring takes place, an interviewee indicated that *"they [the Forest Service] do a lot less than what they used to do. [...] We [the City] don't have expectations of them doing a whole bunch of things that we'd need to be checking out"* (Portland Water Bureau Representative. Personal Communication, June 13, 2016). On a similar vein, when discussing sanctions for noncompliant behavior, a Forest Service representative argued that *"I think it would come down to lawsuits, that's where sanctions would come into play [...]there's none [sanction] that's straight out of the document that*

	BOSTON	NEW YORK	PORTLAND	SAN FRANCISCO
Monitoring				
Individual Action	12 (52.2%)	57 (60.0%)	3 (42.9%)	5 (29.4%)
Joint Work	5 (21.7%)	19 (20.0%)	3 (42.9%)	4 (23.5%)
Generate Information/Conduct study	0	13 (13.7%)	0	3 (17.6%)
Water Quality/Quantity Reports	6 (26.1%)	6 (6.32%)	1 (14.3%)	5 (29.4%)
Compliance				
Third Party	2 (20.0%)	21 (16.4%)	2 (20.0%)	3 (100%)
Definitions	0	36 (28.1%)	2 (20.0%)	0
In-house	1 (10.0%)	16 (12.5%)	1 (10.0%)	0
Individual Party	7 (70.0%)	40 (31.2%)	4 (40.0%)	0
Venue	0	15 (11.7%)	1 (10.0%)	0
Consequence				
Easement restrictions	0	11 (20.8%)	0	0
Administrative action	0	20 (37.7%)	0	2 (40.0%)
Compensation	0	4 (7.55%)	0	1 (20.0%)
Modify obligations	0	14 (26.4%)	0	2 (40.0%)
Define rules that apply	2 (50.0%)	4 (7.55%)	0	0
Consequences for individuals	2 (50.0%)	0	2 (100%)	0
TOTAL	37	276	19	25

Table 3 Types of mechanisms by case.⁷

	P-VALUES					
	PORTLAND VS SAN FRANCISCO	PORTLAND VS BOSTON	SAN FRANCISCO VS BOSTON	NEW YORK VS PORTLAND	NEW YORK VS SAN FRANCISCO	NEW YORK VS BOSTON
Monitoring	0.631	0.631	0.362	0.365	0.052	0.052
Compliance	0.545	0.747	0.141	0.970	0.107	0.141
Consequence	0.214	0.560	0.095	0.002	0.646	0.001

Table 4 Pairwise comparisons of mechanisms types between cases.⁸

says *“this is what happens if you don’t do [something] [...] I think that the dedication to working in partnership really kind of preclude the need for sanctions”* (USFS Mt. Hood Representative. Personal Communication, June 22, 2016).

Similar reasons were identified in San Francisco. A SFPUC respondent mentioned that *“There is no enforcement. There is no ‘if you don’t do this, we’re going to withhold the payment’ [...] it goes back to the fact that we’re dealing with one of the nation’s parks, and they have the same goals as we do.”* (San Francisco Public Utilities Commission Representative. Personal Communication, May 2, 2016). This sentiment was also present on the National Park Service side, where a ranger attributed this absence of sanctions to a *“lack of animosity”* (Yosemite National Park Division Ranger, Personal Communication, April 12, 2016). Another Ranger also mentioned that *“if the city did not comply with what was in the Raker Act, we can take them to Court and say ‘you’re responsible for giving us \$30,000 every year per the Raker Act and you haven’t done that [...] For things like the agreement, [...] the City can come back at us and say ‘you didn’t uphold what you said you would in the agreement’.”* (Yosemite National Park Division Ranger, Personal Communication, March 24, 2016). These interviews indicate that the relative absence of consequence mechanisms is grounded on shared goals.

In Boston, an MWRA representative mentioned *“our approach has been that because we share so many of our viewpoints and our objectives, almost everything has been resolved at that level of staff-to-staff relationship. And if you read the 2004 MOU there’s a lot of dispute resolution stuff in there. We’ve never had to use any of that”* (MWRA representative. Personal Communication, June 3, 2016). Similarly, a member of the MWRA Advisory Board stated that *“Clearly, Court action on any issue could always occur. And it has not been the direction that things have gone”* (MWRA Advisory Board representative. Personal Communication, July 14, 2016). In fact, the MWRA Advisory Board representative provided some evidence as to why the agreements in Boston focus particularly on addressing the behavior of individual users (not signatories of the agreement): *“a major debate that’s been going on is trail*

bike riders, mountain bikers I should call them. They like using the watershed lands as their personal track. They cut trees down to do whatever they want” (MWRA Advisory Board representative. Personal Communication, July 14, 2016). This may explain why the arrangement pays more attention to addressing issues of noncompliance at the individual level, rather than focusing on the compliance of its signatories.

Finally, in New York, the complexity of the arrangement is influenced not only by the history of conflict between the City and watershed communities, but also by the multi-partite nature of their governing arrangement. This requires redundant and interdependent mechanisms, as stated by an interviewee: *“There’s a lot of reporting, we [the City] generate a lot of reports as required by our Filtration Avoidance Determination. And all those get posted up on our website and everybody who wants to see them has access to the. The partner organizations, particularly WAC [Watershed Agricultural Council] and CWC are very transparent. They do their own reporting, and they have active Boards [...] And, also because our program is regulated formally by EPA and now by the State Department of Health, there’s a lot of oversight to make sure that programs are being implemented as intended. So, there are lots of small ways that the parties are communicating or being transparent, are tracking each other’s performance against expectations.”* (NYC Department of Environmental Protection representative. Personal communication. July 7, 2016). The extent of redundancy in monitoring is also a byproduct of the complex institutional architecture of the New York City arrangements, which is also reflected on the compliance and consequence side: *“if something happened and the City was no longer able to acquire land, that could jeopardize the FAD, which would also then jeopardize the funding for the water quality programs. On the other hand, if the City didn’t pay for the water quality programs, that would jeopardize their FAD and also they would lose their Land Acquisition Program”* (CWC representative. Personal Communication, June 17, 2016).

Although these mechanisms have not necessarily been triggered, they contribute to a good working relationship

among the parties. *“unless there’s something extremely important, that for whatever reason cannot be addressed by either the FAD [Filtration Avoidance Determination] regulators with the City and with the Communities, if there’s something that comes up that can’t be, then it will go to the WPPC [Watershed Protection and Partnership Council – the main conflict resolution venue] and it has in the past. [...] otherwise we’ve been successful and continued to be successful in working through these issues without having to essentially pull everybody together and do it that way. But the framework is there, the structure is there to be able to do it. So, we always have that option.”* (New York State Department of Environmental Conservation Representative. Personal Communication, July 12, 2016).

DO LEVELS OF TRANSACTION COST RISKS LEAD TO VARIATIONS IN MONITORING AND CONSEQUENCES?

The overarching expectation of this manuscript stated that higher transaction cost risks should result in more and varied mechanisms to address issues of monitoring, compliance, and rule enforcement. Of the safeguards to minimize transaction costs risks, only monitoring and consequence showed statistically significant differences across the cases studied. These differences, however, are more nuanced than expected and results do not consistently show the case with the highest relative level of transaction cost risks having significantly different monitoring and consequence mechanisms than the others. This is indicative of two things: first, the effects of transaction cost risk on institutional design may not be as lineal as anticipated; and second, that variations in transaction cost risk may not affect the design of monitoring and consequence mechanisms in the same manner.

Regarding the first nuance, New York presented the highest relative levels of transaction cost risks of the four cases, as indicated by the number and type of organizations involved in the agreement as well as by the history of conflict between City and watershed communities. Qualitative evidence from interviews with key actors in Boston, Portland, and San Francisco showed how actors in these cases did not perceive the need for overly developed mechanisms, when the parties to the agreement already had similar goals. As expected, New York showed more monitoring, compliance, and consequence mechanisms than the other three cases (as shown in [Table 3](#)). However, this difference is only on absolute terms. On relative terms, for example, only 34% of all the mechanisms found in New York were coded as monitoring mechanisms (see [Table 2](#)). In Boston and San Francisco, on the other hand, 62.2% and 68% of

mechanisms identified were monitoring, respectively. In Portland, 36.8% of mechanisms were monitoring.

At the same time, Boston, Portland, and San Francisco showed no statistically differences with each other. Even though transaction cost risk might play a role in variations in monitoring mechanisms, that role varies, especially at relatively low levels of transaction cost risk. Agrawal and Goyal (2001), for instance, found a non-monotonic function in the preferences for third party monitoring in arrangements for forests governance. Preferences for certain monitoring approaches vary with size group, particularly as some (such as third-party monitoring) become costly at small and large scales. Even though the arrangements studied here present a variety of monitoring approaches, both New York and Portland rely heavily on unilateral reports and joint work (accounting for more than 80% of the monitoring mechanisms in each case) regardless of the levels of transaction cost risk identified in each case. Although Portland did not show high levels of transaction cost risks, earlier in the history of Bull Run, the Portland Water Bureau and the Forest Service had different goals regarding the use of the resource, which prompted some early conflict between them (Short, 2011). Although addressed after the implementation of the Northwest Forest Plan, remnants of this conflict may have forced their way into subsequent agreements.

The second nuance is evident in the case of consequence mechanisms. Although New York differs again from Boston, results show statistically significant differences with Portland but not San Francisco. In addition, Boston also shows a statistically significant difference with San Francisco. Not only does New York differ from two cases with lower levels of transaction cost risk, but also Boston differs with a case with lower relative transaction costs, such as San Francisco. These findings, plus the absence of statistically significant differences in compliance mechanisms indicate that transaction cost risks may influence preferences for mechanism design in different ways, depending on the mechanism.

CONCLUSION

This paper analyzed the design of intergovernmental arrangements created to secure access to high-quality drinking water in four large cities in the United States. Building on literatures on transaction costs, this paper assessed whether differences in transaction costs risks are associated with variations in the design of monitoring, compliance, and consequence in the governance of shared water resources. Although similar work has been conducted at the international scale, comparing mechanism design across a variety of treaties (Koremenos, 2016), little work

has been done in analyzing mechanism design within a country (for some exceptions, see Hanlon et al., 2019; Heikkila et al., 2011; Schlager et al., 2021).

Findings provide insights on the calculated decisions involved in designing intergovernmental arrangements for the governance of shared water resources. When facing different levels of transaction cost risks, actors design monitoring and consequence mechanisms differently, at least when compared to cases with high levels of transaction cost risk. However, these differences are neither as lineal nor as consistent as expected. This study contributes to the understanding of institutional design at regional scales by showing that not only the presence of mechanisms is important but also that their design varies to address different levels of transaction costs. Recent studies in the common pool resource literature have highlighting the need of furthering our understanding of the features of specific design principles, rather than just relying on their presence or absence to assess the effectiveness of an institutional arrangement (see, for instance, Baggio et al., 2017).

On a practical sense, these findings may orient practitioners to pay special attention to the design of monitoring and consequence mechanisms when drafting regional governing arrangement, tailoring them to the features of their cases. In the case of compliance, findings seem to indicate that practitioners may not need to rely on overly specific mechanisms, and instead could borrow from other arrangements or build on existing compliance mechanisms.

The four cases studied are useful to assess how governments dealing with similar policy problems address them under different transaction costs risk scenarios. First, all four have succeeded in maintaining unfiltered status, showing that the arrangements are effectively maintaining collective action. Second, having two cases in the American west (Portland and San Francisco) and two cases in the east (Boston and New York) helps control for regional variations of issues such as water appropriation rights. Having a case with extreme values in the independent variable such as New York provides useful when the goal is to assess the strength of initial theoretical assumptions, as well as to identify potential intervening variables that were not hypothesized (Seawright, 2016).

A large amount of ground remains uncovered, and this paper is not devoid of limitations. Although the goal of this paper is to assess the *joint* effect of transaction cost risks (defined by the number of actors involved and the history of their relationships), future research should further disentangle the role of these indicators. Future work should also assess whether these hypotheses hold in other settings operating under filtration waivers. Although the four cases studied here are four of the largest settings

operating under such a waiver, these arrangements could be compared to others in place throughout the country. In addition, this paper relied on an inductive approach to identify types of monitoring, compliance, and consequence mechanisms. Developing broader typologies would allow assessing these results in other types of intergovernmental agreements. Finally, this paper only analyzed the role of institutions as rules-in-form without paying attention to how those institutions operate in practice. Future studies should inquire about the performance of these mechanisms and how (and if) they operate as rules-in-use.

ADDITIONAL FILE

The additional file for this article can be found as follows:

Additional Materials. Appendices A, B and C. DOI: <https://doi.org/10.5334/ijc.1123.s1>

NOTES

1. Other cities providing unfiltered water include Seattle (Oregon) and Portland (Maine) (Alcott et al., 2013; US Environmental Protection Agency, 1999).
2. In Boston, 6 interviews were conducted with representatives from Massachusetts Water Resource Authority (MWRA); Department of Conservation and Recreation, Division of Water Supply (DCR); MWRA Advisory Board; Massachusetts Executive Office of Energy and Environmental Affairs; Water Supply Protection Trust; and Watershed Citizens Advisory Committee (WSCAC). In Portland, 3 interviews were conducted with representatives from the Portland Water Bureau and with Mt. Hood National Forest (U.S. Forest Service – USFS). 6 interviews were conducted in San Francisco with representatives from Yosemite National Park, National Park Service (NPS); Hetch Hetchy Water and Power Division, San Francisco Public Utilities Commission (SFPUC); Water Quality Division, San Francisco Public Utilities Commission; and the Natural Resources and Land Management Division, San Francisco Public Utilities Commission. Finally, 8 individuals were interviewed in New York, representing New York City Department of Environmental Protection (NYCDEP); Coalition of Watershed Towns (CWT); Catskill Watershed Corporation (CWC), Delaware County Soil and Water Conservation District; New York State Department of Environmental Conservation (NYSDEC); New York State Department of Health (NYSDOH); and U.S. Environmental Protection Agency (U.S. EPA).
3. Appendix B defines the role of each document in each case.
4. New regulations, 313 CMR 11.00, were issued in February 2017 in response to an Executive Order from the Governor mandating a review of all state regulations. These regulations were issued after most of the coding and data analysis was done for this manuscript. There are no significant differences in content between 350 CMR 11.00 and 313 CMR 11.00.
5. Some observations included mechanisms with only 2 institutional statements, where each statement was coded as a different mechanism, thus making it not possible to distinguish which of the two categories is the predominant. Those observations were removed from the dataset.
6. Although communities and local interests do provide input on watershed plans and projects.
7. Percentages indicate mechanism type per case.
8. Values in each cell are p-values adjusted using the procedure defined in Benjamini and Hochberg (1995).

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COMPETING INTERESTS

The author has no competing interests to declare.

AUTHOR AFFILIATION

Tomás Olivier  orcid.org/0000-0003-1101-1875

Florida Atlantic University, US

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