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The Role of Independent Regulatory Agencies in Water Access: Evidence from Latin America and the Caribbean

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The Role of Independent Regulatory Agencies in Water Access: Evidence from Latin America and the Caribbean

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Abstract

This empirical study investigates the impact of independent regulatory agencies on access to safely managed water in the region during 2000-2022. Utilizing a dynamic panel estimator with bootstrap-based bias correction, we find a positive effect of these agencies. Notably, their impact increases over the first 21 years until reaching a peak. Additionally, our analysis reveals that countries governed by left-wing parties over extended periods experience lower access rates. However, no evidence of political interference in the agencies' impact on water access is found.

Keywords: water and sanitation sector, access to safely managed water, independent regulatory agencies, Latin America and the Caribbean

JEL codes: Q21, O13, O54, Q25

1 Introduction

Access to clean and safe water continues to be a global problem. In 2022, 296 million people suffered from unimproved access, and 1.5 billion still lacked safely managed drinking water worldwide. However, within the Latin American and Caribbean (LAC) region, substantial steps have been taken in terms of water access.

As of 2015, approximately 96% of the LAC population had attained access to at least a basic drinking water service. However, a substantially lower share of the population benefits from a safely managed drinking water service, having stagnated at 75% (WHO UNICEF, 2023b). In this context, and recognizing that the delivery of public services directly influences the lives and livelihoods of service users through the accessibility and reliability of services, identifying determinants of increases in the population with access to safely managed water could be crucial to achieving universal access to clean and safe water in the LAC region (SDG 6.1).

Historically, the institutional framework has shaped the landscape of water regulation and access in LAC. Traditionally, water supply in LAC, as in other regions, has been a municipal function. However, in

most parts of the region, municipalities constitute a weak level of government with limited autonomy and financial independence (CEPAL, 1985). Countries within the region have implemented various reforms to enhance water governance. One of the most significant transformations in the global public sector over the past decades has been the delegation of regulatory tasks from the core bureaucracy to agencies that often operate independently of elected politicians (Majone, 2019), and the water sector in LAC is no exception.

By the late 1990s, nearly every nation in the region had initiated some form of sector reform (Foster, 2005). Chile set a starting point with its reform in 1988. Following Chile's lead, countries such as Argentina, Mexico, Peru, Colombia, Bolivia, and Brazil underwent significant shifts. Although no country in the region has fully implemented all facets of comprehensive reforms, which partially aimed to incentivize private participation in the sector, these reforms have effectively marked the conclusion of an era characterized by state regulation of the sector. In its place, Independent Regulatory Agencies (IRAs) have been established to oversee various aspects, including economic regulation, standard setting, licensing issuance and enforcement, and the prevention of abuse of dominant market positions. Initially established to facilitate economic regulation, IRAs were also assigned responsibilities encompassing "social" dimensions, akin to those discussed by Thatcher (2002b) in the context of electricity. These responsibilities included tasks such as promoting universal access to services and protecting consumers from exploitation.

Despite the normative significance of such institutions, there is a noticeable lack of studies evaluating the effects of their existence on water access. Indeed, while the relationship between sectoral reforms and energy outcomes has been analyzed on both global and regional scales (Imam, Jamasb, and Llorca, 2019a), the extent to which institutional features are associated with water outcomes has received limited attention. Estache, Goicoechea, and Trujillo (2009) explored the effect of introducing IRAs on access, service quality and affordability in the energy, telecommunications, and water sectors across a sample of 153 developing countries during the period 1990-2002—a time of heightened regulatory activity when IRAs may not have fully matured.

In the pursuit of their mandates, IRAs were anticipated to correct market failures (Majone, 1997), such as the stagnation of water coverage, and consequently, they are expected to incentivize the extension of water services to the millions within the region currently devoid of access. But do countries with IRAs indeed exhibit better water coverage levels? To what extent does access improve in the presence of IRAs? Furthermore, one prevailing theoretical explanation for the emergence of IRAs emphasizes the need for credible commitment as a policy-making tool (Gilardi, 2002; Majone, 1997), and to establish credible policy regimes by limiting political interference in regulatory matters (Gilardi, 2002; Majone, 1997). In this context, we raise a critical question: Does government ideology influence IRA performance concerning water access?

This paper empirically examines the impact of water sector reforms, specifically the adoption of IRAs, and their interaction with ideology on water access in LAC countries. To achieve this, we construct a

panel dataset comprising data from 12 LAC countries reporting information related to access to safely managed water during the period 2000-2022. Methodologically, we employ a dynamic panel estimator, specifically a Least-Squares Dummy Variables (LSDV) estimator with a bootstrap-based bias correction. This approach effectively addresses the inconsistency of the estimator inherent in dynamic panel models with fixed time dimensions. Our results highlight the positive effect of IRAs on access to safely managed water. Furthermore, we find that the influence of IRAs strengthens over time, reaching its peak after approximately 21 years. Last, we do not uncover evidence of political interference in IRAs leading to lower access rates. However, it is worth noting that the longer a left-wing party remains in office, the lower the rate of access to safely managed water.

2 Context

2.1 IRAs as a global trend

According to the Bonn Charter ([International Water Association, 2004](#)), a high-level framework that outlines the operational and institutional prerequisites for managing water supplies, the provision of reliable access to safe drinking water is foundational to the well-being of a community and its economic development. To achieve this objective, the establishment of an effective management framework is of paramount importance. These responsibilities do not necessarily have to be entrusted to a single authority; instead, multiple entities can be established to fulfill these roles. In the 1990s, a significant global shift occurred in the perception of urban water supply, transforming it from a public good provided to citizens into an economically valued cornerstone of water regulation ([Bakker, 2007, 2011](#)). This shift was part of a broader international trend marked by extensive privatization efforts. During this transformative period, regulatory agencies (RAs) proliferated at the national level across various sectors, including the water sector, influenced by well-established institutional models in some Anglo-Saxon countries and propelled by a diffusion process that gained momentum from the 1980s onwards ([Jordana, Levi-Faur, and i Marín, 2011](#)). Notably, the outsourcing of regulatory functions from the core bureaucracy to agencies operating at arm's length from elected politicians emerged as a prominent feature of this global transformation ([Majone, 2019](#)). In many countries over the past three decades, the prevailing trend has been the creation of a public entity designed to operate independently from government, service providers, and administration, known as IRAs. The rationale for autonomous regulatory bodies has been sustained by the belief that the separation of regulation, service provision, and policymaking is preferable, as it enhances transparency and ensures the maximum benefit for all stakeholders. A predominant theoretical explanation for the discernible shift in the public sector centers on the imperative need to safeguard regulatory processes from unwarranted political interference, thereby augmenting the credibility and efficacy of policy regimes ([Estache et al., 2009; Thatcher, 2002b](#)). This aligns with the fundamental notion that establishing an imperatively credible

commitment entails limiting the government's discretion to deviate from the originally stated policy. A crucial institutional strategy employed to achieve this objective involves the delegation of execution to an intermediary not directly bound by governmental directives (Epstein and O'halloran, 1999), as evidenced in the establishment and operation of IRAs.

Persistent concerns over corruption prompted the creation of technocratic, non-electoral institutions like IRAs, which play a pivotal role in determining tariffs based on investment sustainability and, to a lesser extent, the redistributive effects of price structures (Foster, 2005). In the domain of urban water supply, IRAs function as a linchpin in upholding the commitment to effective policy implementation while mitigating the inherent risks associated with potential political influence (Hanretty and Koop, 2012).

2.2 IRAs in LAC

Water sector reforms in the LAC region are closely tied to the establishment of IRAs. This connection is grounded in the pivotal role that these agencies play in implementing and overseeing reforms within the water sector, as well as in enforcing policies and standards and promoting investment. In this regard, the countries under study can be broadly categorized into two groups: those with an IRA and those without.

As can be observed in Table 1, by the end of 2023, only 4 out of the 12 countries in the sample – Dominican Republic, Mexico, Guatemala, and Suriname – have not established an IRA for the sector.¹ However, in the case of the Dominican Republic, there has been an initiative under discussion for more than a decade and economic regulation has been identified as one of the important challenges in water policymaking (iAgua, 2019; Akhmouch, 2012).

In the LAC water and sanitation sector, IRAs are commonly found. The establishment of such entities has increased over time. In the 1980s and early 1990s, there were some instances of IRAs creation, but the pace of establishment notably accelerated from the mid-1990s. As the 21st century started, 4 out of the 8 countries in the sample with IRA at the end of the period of analysis had already established this institution. Nevertheless, the most significant concentration of IRAs' creation is observed between the years 2000-2004, totaling 3 new IRAs during that period. The case of Ecuador stands out, as the creation of its IRAs does not align with a regional trend in establishing such institutions, occurring half a decade after the most recent documented case in this study. This observation highlights the importance of these institutions in the region, even in contexts unrelated to privatization trends. One prerequisite for effective regulation is to secure enough institutional, operational, and financial autonomy for regulatory bodies. This involves ensuring the stability and independence of these entities, allowing them the freedom to make decisions within their legal boundaries, while remaining subject to judicial oversight. However, it is

¹For this paper, we identified IRAs by country under analysis based on data available in the Global Analysis and Assessment of Sanitation and Drinking-Water (GLAAS) database. It is assumed that an autonomous regulator possesses the authority to regulate various aspects related to the delivery of urban water and sanitation services. However, in all cases, the legal instruments leading to the establishment of IRAs have been scrutinized to address potential variations in approach

also essential for the regulator to ensure the execution of government-defined public policies within the sectors they oversee.

Table 1: IRA by country in LAC

Country	Name of the IRA	Year of creation	Legal Instrument by which IRA is created
Brazil	Agencia Nacional de Águas e Saneamento	2000	Law 9,984/00
Chile	Superintendencia de Servicios Sanitarias	1989	Law 18,902
Colombia	La Comisión de Regulación de Agua Potable Saneamiento Básico (CRA)	1994	Law 142/94
Costa Rica	Autoridad Reguladora de los Servicios Públicos (ARESEP)	1991	Law of the Autoridad Reguladora de los Servicios Públicos (ARESEP) No. 7,593
Dominican Republic	-	-	-
Ecuador	Agencia de Regulación y Control del Agua (ARCA)	2014	Executive decree No. 310
Guatemala	-	-	-
Honduras	Ente Regulador de los Servicios de Agua Potable y Saneamiento (ERSAPS)	2004	Decree No. 118, 2003
Mexico	-	-	-
Paraguay	Ente Regulador de Servicios Sanitarios	2000	Law 1614/2000
Peru	Superintendencia Nacional de Servicios y Saneamiento	1992	Decree-law No. 25965
Suriname	-	-	-

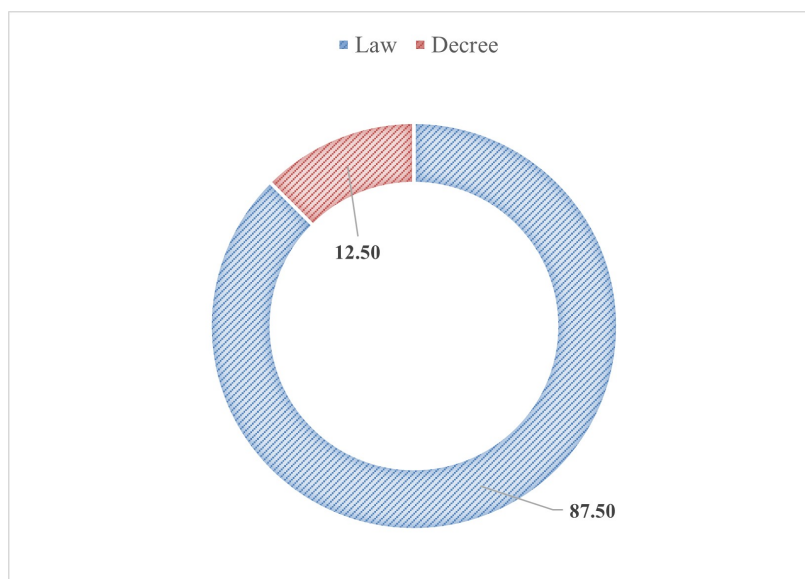
2.3 The formal independence of IRAs

As this study focuses on the relationship between ideology and IRA performance, it is interesting to first analyze the formal independence of the institutions under consideration. This independence should be of a technical, administrative, and financial nature, yet it should not be divorced from the broader long-term national policy goals (Heller, 2017). As an example, in the context of Costa Rica, the law that establishes ARESEP explicitly states that the IRA is not bound by the directives of the Executive Power when carrying out the authorities granted to it by this law. Nonetheless, it retains its accountability to the national development plan, the relevant sectoral plans, and the sectoral policies issued by the Executive Power. Several factors should be considered when assessing the level of independence of any institution. For example, one can consider the legal framework that establishes it, the composition of its board of directors, and the method by which it is funded. The legislative framework typically provides a higher level of stability because it requires a more complex process to be modified, often needing consensus in parliament.

In contrast, a regulatory decree can be easily replaced by another decree when there is a change in executive leadership. Moreover, the extent to which an institution relies on financial support from the national government and whether the composition of its board is based on technical expertise or influenced by political considerations can significantly impact the institution's independence. In a theoretical context, these factors play a crucial role in determining institutional autonomy.

Figure 1 indicates that 7 IRAs, constituting 87.5% of the total, were established through legislative enactments. In contrast, only 1 was created through some form of executive decree. It is important to note that, additionally, no non-IRA is considered self-regulated within our sample. The legal instruments governing the establishment of these IRAs show significant variation in board composition across different countries. The prevailing practice often involves the appointment of the administration board by the Head of Government. This appointment can be solely based on technical expertise in some cases, while in others, the board members may possess a political background or a combination of both. For example, in Panama, the administration board comprises two Ministers and three individuals appointed by the President of the government. The General Administrator, chosen based on technical expertise by the President and ratified by the Parliament, has a voice but cannot cast a vote. In Colombia, the board of directors of the CRA includes appointed experts as well as government-appointed members. The board chairperson is the Minister of Housing, and in case of a tie, the Minister has the tie-breaking vote. There are also cases where parliamentary bodies play a role in the appointment of the IRA board, with variations in their level of involvement. Some countries in the region simply consult the opposition (Belize), while in others, a formal vote by Parliament is required.

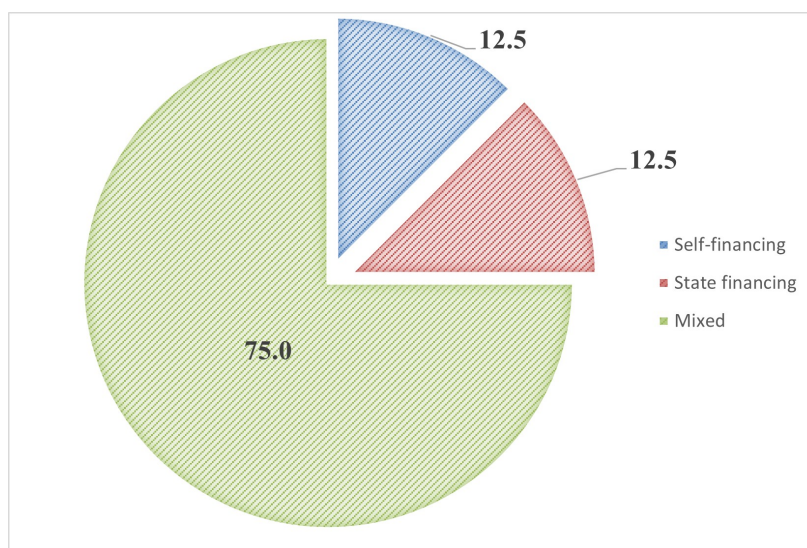
Figure 1: Type of legal instrument by which the IRA was established (%)



Source: own elaboration.

Figure 2 provides an overview of the theoretical funding sources for IRAs based on the legal instruments governing their establishment. The delineated sources imply that, notwithstanding the intended autonomy, IRAs may resort to state transfers, especially during exigent circumstances. While government transfers are not explicitly delineated as a funding source in only one country (Colombia), this characteristic is also discernible in countries within the region, such as Panama and Guayana. In contrast, in Chile, the legal framework explicitly mandates that the agency's financing is exclusively contingent upon transfers from the Public Sector Budgets. Other countries adopt a combination of public transfers and funds disbursed to, or collected by, the Commission under its mandated competencies. Occasionally, international aid is also considered as a source of funding. However, it is noteworthy that in practice, the situation may differ. [Molinari \(2021\)](#), who gathered primary information from 21 regulators in LAC, revealed a distinct funding landscape. According to this empirical data, 11 of the regulators are self-financed, while only seven operate with a mixed funding system. For example, in Honduras, Uruguay, Peru, Paraguay, and Costa Rica, IRAs received financial support from multilateral organizations such as the Inter-American Development Bank.

Figure 2: Source of IRA funding (%)



Source: own elaboration.

The diverse configurations of these agencies across the region, encompassing variations in the legal frameworks that establish them, the composition of their boards of directors, and the methods by which they are funded, place fundamental questions regarding their operational mechanisms and susceptibility to political influences. In the upcoming sections, we explore these crucial aspects, shedding light on the intricate dynamics that shape the functionality and effectiveness of IRAs in LAC.

3 Literature review and Hypotheses

Understanding the intricate interplay between regulatory frameworks, key stakeholders, and access to water services is essential for devising effective policies to achieve and sustain universal access to these services. However, within water literature, there is a lack of studies investigating the influence of regulation on water access. Indeed, most of the research on the regulation of water access is descriptive (Foster, 2005; Andrés, Schwartz, and Guasch, 2013; Bertomeu Sanchez and Serebrisky, 2018; Bertomeu Sanchez, Camos Daurella, and Estache, 2017). As noted in the introduction, when examining the impact of IRAs in the water sector, only one previous study was identified. Estache et al. (2009) scrutinized this relationship within the temporal scope of 1990-2002, integrating datasets from two discrete periods. Their results suggest that the presence or absence of an IRA did indeed affect the access rate in the water sector, but the impact did not reach statistical significance. While their findings hint at a lack of statistical significance regarding the influence of an IRA on water access rates, it is essential to note the potential limitations, such as the cross-sectional nature of the study and the specified periods.

Nevertheless, studies have found several factors that could be associated with this interplay. Insights gathered from analogous sectors can potentially offer valuable perspectives to explore within the domain of water and sanitation.

The literature addressing the impact of regulation on outcomes in developing countries telecom markets is one of the more mature areas of study. Empirical evidence in this domain consistently indicates a positive correlation between regulation and mainline penetration rates, as well as efficiency gains (Fink, Mattoo, and Rathindran, 2003; Gutiérrez, 2003; Wallsten, 2003). Similarly, in the energy sector, investigations focusing on developing countries also demonstrate positive effects of regulation on energy generation capacity (Cubbin and Stern, 2004; Nakano and Managi, 2008; Eberhard and Naude, 2016; Imam et al., 2019a). Regarding access rates, evidence from the energy sector also suggests a positive relationship with the presence of an IRA (Imam et al., 2019a; Imam, Jamasb, and Llorca, 2019b; World Bank, 2017).²

Moreover, the effect of regulation on the performance of electricity generation is not straightforward. Zhang, Parker, and Kirkpatrick (2008) observed that the impact of privatization and the presence of an independent regulator, when considered individually, were statistically insignificant in influencing the performance of the electricity generation industry. However, the simultaneous implementation of these two reforms demonstrated a significant positive correlation with increased electricity availability and enhanced generation capacity. Consequently, the first hypothesis to be tested is as follows:

Hypothesis 1: *Establishing an IRA has a positive effect on access to water in LAC.*

²The comparison of water sector regulation with energy and telecommunications should consider the natural monopoly characteristics that water services typically retain. Unlike energy generation or telecommunication services, which can exhibit more competition, the water sector tends to remain a local monopoly due to its infrastructure-heavy nature and the need for localized distribution. This fundamental difference limits the scope for competition-driven efficiency and innovation, highlighting the crucial role of IRAs in ensuring transparency and accountability in the water sector Andrés et al. (2013).

Moreover, [Imam et al. \(2019a\)](#) highlight that the impact of regulation tends to increase with the age of the regulator. Their findings suggest a long-term effect, with regulators aged over three years exhibiting a 35% increase in per capita generation capacity. They identify the peak impact occurring at 15 years. Similarly, [Andrés et al. \(2013\)](#) show that the experience of regulatory agencies, measured by the number of years since their establishment, correlates with gradual improvements in utility performance in both the water and energy sectors. Over time, regulatory agencies tend to contribute to better outcomes, including coverage, increased labor productivity, reduced distributional losses, and improved cost recovery ratios. However, contrasting studies have shown a negative relationship between regulatory age and performance ([Nagayama, 2010](#); [Zhang et al., 2008](#)). Some research argues that countries may continue to face social and economic challenges post-reforms due to insufficient investment levels necessary to improve generation capacity, enhance service reliability, and increase access rates ([Auriol and Blanc, 2009](#); [Rosnes and Shkaratan, 2011](#); [Ahlborg, Boräng, Jagers, and Söderholm, 2015](#)). In this context, the second hypothesis to be tested is as follows:

Hypothesis 2: *The influence of an IRA on water access strengthens over time following its establishment. Initially, regulatory activity exhibits an upward trajectory, gradually reaching a plateau.*

Politician's behavior is expected to affect economic policy. The partisan approach focuses on the role of party ideology and shows that, leftist parties typically prioritize expansionary fiscal and monetary policies, whereas right-wing parties, which cater more to capital owners, are primarily focused on controlling inflation ([Potrafke, 2011](#); [Hibbs, 1977](#)). Theoretical explanations suggest that individuals endorsing left-wing ideology are likely to promote progressive social change, whereas individuals endorsing right-wing ideology are likely to promote reactionary social change ([Becker, 2020](#)). Moreover, aligning with the stylized and widely accepted fact that left-wing governments spend more ([Potrafke, 2018](#)) and expanded cash transfers and public services ([Niedzwiecki and Pribble, 2018](#)). In line with this, from the energy sector, [Imam et al. \(2019a\)](#) revealed that countries with right-wing governments exhibit lower access to electricity compared to those with centrist governments, while access rates in countries with left-wing governments do not significantly differ from those with centrist governments.

The relationship between government ideology and water access remains underexplored. However, the impact of government ideology on the contracting out of water services has been extensively studied, yielding mixed results. Some studies suggest that contemporary governments prioritize practical considerations in their decision-making processes ([Bel and Fageda, 2007](#)). In contrast, other research emphasizes the significant role of ideological factors in shaping regulatory frameworks, which in turn affect access to essential services ([Cunial, 2023](#)).

Considering all the foregoing, the third hypothesis to be tested would be:

Hypothesis 3: *Left-wing governments are associated with higher access to water.*

Operational autonomy from elected politicians is a fundamental aspect of IRAs. While this autonomy reduces the risk of capture, it does not entirely eliminate it. Extensive research has examined the politicization of regulatory agencies (Thatcher, 2005; Ennser-Jedenastik, 2015), yet the influence of ideology remains an additional factor deserving attention. However, evidence regarding the impact of ideology on the performance or outcomes of IRAs is limited. According to Gilardi (2008), left-wing administrations often establish IRAs as a commitment device to safeguard against post-reform interventionist policies, prioritizing consumer protection and social regulation. Conversely, right-wing governments typically emphasize economic regulation over social policies, potentially shaping the priorities of IRAs in promoting public service expansions that enhance water access.

Consequently the fourth hypothesis to be tested is:

Hypothesis 4: *Left-wing governments' interference in IRAs leads to improve access to water.*

However, to the best of the authors' knowledge, this aspect has only been explored by Imam et al. (2019a). Imam et al. (2019a) investigate how regulatory reforms impact access to electricity in Sub-Saharan Africa, explicitly considering the influence of political ideology. Their findings suggest that IRAs in countries governed by left-wing parties may have a diminished impact on access rates compared to those in centrist or right-wing governed countries, highlighting ideological variations in regulatory outcomes.

Moreover, most research exploring the relationship between ideology and essential services typically operationalizes ideology as a static phenomenon. In this regard, Beuve and Le Squeren (2016) argue that the management of public services is path-dependent, suggesting that ideology should be measured over the long-term rather than as a simple dummy variable. Therefore, one of the novelties of this paper is measuring the relationship between ideology and water access considering the path-dependent nature of the latter variable

4 Data and variables

We construct a panel dataset comprising annual observations for 12 LAC countries³ over the period 2000 to 2020. Our data originate from four distinct sources. First, we obtained information on water access rates from the WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation, and Hygiene (JMP). Second, data related to IRAs were collected from the UN-Water Global Analysis and Assessment of Sanitation and Drinking Water survey. Third, information regarding governments' ideology was sourced

³In this study, we focus on the countries within LAC that report information on safely managed water. Specifically, our analysis includes Brazil, Chile, Colombia, Costa Rica, the Dominican Republic, Ecuador, Guatemala, Honduras, Mexico, Paraguay, Peru, and Suriname. However, it is crucial to acknowledge that our results may be subject to selection bias due to the exclusion of other LAC countries from our dataset. While we recognize this limitation, our findings provide valuable insights into the water management practices of the included nations.

from the Database of Political Institutions 2020. Finally, we retrieved control variables from the World Bank Development Indicators Database.

Our dependent variable, *WA*, is the proportion of the population using safely managed water services, which are defined as “drinking water from an improved water source that is accessible on premises, available when needed and free from faecal and priority chemical contamination”. That is, our variable of interest is the indicator 6.1.1 related to the previously mentioned SDG target 6.1. As key explanatory variables, we consider *IRA*, a dummy variable that takes value 1 if there is an IRA for a given country and time period, and 0 otherwise. The governments’ ideology is included following [Beuve and Le Squeren \(2016\)](#). Specifically, we construct two variables, *yearsleft* and *yearsright*, that account for the number of years that a left-wing or a right-wing government, respectively, have been in office. These variables allow one to consider that the procurement of public services such as water may be path-dependent, i.e., the access to safely managed water services in a given period may be strongly connected to decisions made in previous periods by a government. Moreover, these two indicators are interacted with the *IRA* dummy variable to test for the potential government influence on the *IRA*. Given that these institutions are established by the national parliament or government and are expected to operate uniformly across the entire country, it should be emphasized that the variable of ideology encapsulates the ideological stance of the national government despite the inherently decentralized nature of the water sector. In the event of discernible ideological influence on the performance of IRAs, it is considered that such influence would emanate from the government, as opposed to local politicians, owing to their potential sway over these institutions ([Correa, Melo, Mueller, and Pereira, 2019](#)).

In terms of control variables that represent the demand side, we include GDP per capita (*gdp_pc*), as one would expect that higher development levels are positively associated with higher water access rates ([García-López, Cuadrado-Quesada, and Montano, 2023](#); [Lawrence, Meigh, Sullivan et al., 2002](#)); population density (*pop_density*), since higher population density may result in economies of customer density and scale ([Pérez-Urdiales, Vidal, and Libra, 2023](#)), which may have facilitate achieving higher water access rates; and the proportion of the population living in urban areas (*urban*), as urban areas may be positively associated with higher access rates ([Chaudhuri and Roy, 2017](#); [Cole, Bailey, Cullis, and New, 2018](#); [Anbarci, Escaleras, and Register, 2009](#); [Satterthwaite, 2017](#)). Last, we also include an index measuring corruption of the public sector, as it can have a detrimental impact on the effectiveness of reform policies ([Estache et al., 2009](#); [Breen and Gillanders, 2024](#)).

Table 2 shows some descriptive statistics and descriptions for the variables included in the analysis. Moreover, the correlation between the dependent variable and the explanatory variables is shown in Table 4 in the appendix.

Table 2: Summary statistics

	Definition	Mean	Std.Dev.	Min	Max	N
Dependent variable						
<i>WA</i>	Access to safely managed water (%)	61.96	16.40	39.59	98.77	276
Explanatory variable						
<i>IRA</i>	=1 if <i>IRA</i> for given country and time period	0.54	0.50	0.00	1.00	276
<i>IRAYears</i>	Age of <i>IRA</i>	8.39	9.74	0.00	32.00	276
<i>yearsleft</i>	No of years left-wing party in office	2.02	3.71	0.00	17.00	252
<i>yearsright</i>	No of years right-wing party in office	3.34	9.41	0.00	54.00	252
<i>leftIRA</i>	<i>yearsleft</i> $\times$ <i>IRA</i>	1.35	3.29	0.00	17.00	252
<i>rightIRA</i>	<i>yearsright</i> $\times$ <i>IRA</i>	2.79	9.40	0.00	54.00	252
Control variables						
<i>gdp_pc</i>	GDP in million of dollars	6035.67	3466.10	1079.62	16239.93	264
<i>pop_density</i>	Population density	38.63	56.54	0.48	215.31	276
<i>urban</i>	Urban population (%)	69.99	12.18	45.33	87.91	276
<i>corrup_public</i>	Public sector corruption index	0.48	0.23	0.06	0.90	276

5 Empirical strategy

As a starting point for empirically analyzing the impact of IRAs and political ideologies on access to safely managed water⁴, we propose the following model:

$$\ln(WA_{it}) = \alpha_i + \beta_1 IRA_{it} + \beta_2 \ln(Z_{it}) + \epsilon_{it} \quad (1)$$

Where:

- $\ln WA_{it}$ represents the natural logarithm of access to safely managed water at time t for country i,
- IRA_{it} is an indicator variable for the presence of an independent regulatory agency,
- Z_{it} denotes a vector of control variables,

⁴An alternative hypothesis to test is whether IRA's and political ideologies have an impact on the rate of access to safely managed water, i.e., the percentage annual change in the level of access. However, it would require to transform Equation (1) by taking first differences. This transformation has two main implications, which can difficult the analysis. First, given that the initial variable *WA* is the percentage of population with access to safely managed water, as defined in Section 4 and particularly Table 2, the annual change in that variable, i.e., $\Delta(WA_{it})$ takes values close to zero, which may prevent estimation. In particular, this variable has a mean of 0.0065 and standard deviation of 0.0063. Second, since the *IRA* variable is a dummy variable that takes value 1 when a country has an IRA, the resulting variable ΔIRA will only take value 1 for the adoption year, i.e., the year in which the IRA is created, and 0 for the remaining years. Given the low variability of this variable, it is unlikely to capture the effect of IRA on access. This change will also affect the interaction of this variable with the ideology variables. Consequently, this model is not considered in this study.

- α_i captures country-specific fixed effects related to time-invariant unobservable characteristics,
- the parameters β s are estimated coefficients,
- and ϵ_{it} represents the idiosyncratic error term with mean 0 and variance σ^2 .

As highlighted by [Imam et al. \(2019a\)](#), estimating Equations (1) using a pooled Ordinary Least Squares (OLS) estimator is problematic as it would yield inconsistent and unreliable results. To address this, one could use a Fixed Effects (FE) estimator. However, access to safely managed water may be dynamic in nature as decision makers may not be able to immediately respond to changes in their environment ([De Vos, Everaert, and Ruysen, 2015](#)). In this context, the conventional approach involves adding the lagged dependent variable to the FE model. Therefore, Equations (1) and (??) can be written as the following dynamic panel data models:

$$\ln(WA_{it}) = \alpha_i + \gamma \ln(WA_{it-1}) + \beta_1 IRA_{it} + \beta_2 \ln(Z_{it}) + \epsilon_{it} \quad (2)$$

$$\begin{aligned} \ln(WA_{it}) = & \alpha_i + \gamma \ln(WA_{it-1}) + \beta_1 IRA_{it} + \beta_2 yearsleft_{it} + \beta_3 yearsright_{it} + \\ & \beta_4 yearsleft_{it} \times IRA_{it} + \beta_5 yearsright_{it} \times IRA_{it} + \beta_6 \ln(Z_{it}) + \epsilon_{it} \end{aligned} \quad (3)$$

[Nickell \(1981\)](#) demonstrated that the FE estimator becomes inconsistent when the number of cross-sectional units (N , representing countries in our case) approaches infinity while the number of time periods (T) remains fixed. Consequently, several generalized method of moments (GMM) estimators have been proposed. Among these, difference GMM ([Arellano and Bond, 1991](#)) and system GMM ([Arellano and Bover, 1995](#)) estimators are commonly used. However, caution is warranted: these instrumental variable-based models may exhibit poor small-sample properties due to weak-instrument issues, larger standard deviations compared to the FE estimator, and highly unstable estimates across different instrument sets ([De Vos et al., 2015](#)). Given the lack of dominance of cross-units over time periods in our panel, GMM estimators would also lead to biased results.

Given our specific database, we use the bootstrap algorithm proposed by [Everaert and Pozzi \(2007\)](#) to correct the bias of the FE estimator. First, we transform each variable in our model into deviations from individual specific-sample means, so that the individual effects α_i are eliminated. Specifically, we take the average of both sides of Equation (2):

$$\overline{\ln(WA_{it})} = \alpha_i + \gamma \overline{\ln(WA_{it-1})} + \beta_1 \overline{IRA_{it}} + \beta_2 \overline{\ln(Z_{it})} + \overline{\epsilon_{it}} \quad (4)$$

Then, we transform Equation (2) by demeaning both sides:

$$\widetilde{\ln(WA_{it})} = \gamma \widetilde{\ln(WA_{it-1})} + \beta_1 \widetilde{IRA_{it}} + \beta_2 \widetilde{\ln(Z_{it})} + \widetilde{\epsilon_{it}} \quad (5)$$

which can be rewritten as:

$$\ln(\widetilde{WA_{it}}) = \delta \widetilde{W_{it}} + \widetilde{\epsilon_{it}} \quad (6)$$

where $\delta = (\gamma, \beta_1, \beta_2)$ is a vector of parameters to be estimated, and $\widetilde{W_{it}} = (\ln(\widetilde{WA_{it-1}}), \widetilde{IRA_{it}}, \ln(\widetilde{Z_{it}}))$ is a vector of demeaned explanatory variables. The LSDV estimator for $\hat{\delta}$ in Equation (6) is given by:

$$\hat{\delta} = (\widetilde{W_{it}}' \widetilde{W_{it}})^{-1} \widetilde{W_{it}} \ln(\widetilde{WA_{it}}) \quad (7)$$

Following [Everaert and Pozzi \(2007\)](#), $\hat{\delta}$ is biased and still an unknown function of the true parameter vector. An unbiased estimator for δ can be obtained as the mean of the LSDV estimator over J bootstrap samples.

This estimator is identified through an iterative bootstrap bias correction procedure described by the following steps:

1. Estimate the residuals $\widetilde{\epsilon_{it}} = \ln(\widetilde{WA_{it}}) - \delta \widetilde{W_{it}}$.
2. For a chosen number of bootstrap samples B , with $j = 1, \dots, B$:
 - (a) Draw a bootstrap sample ϵ^b from $\widetilde{\epsilon}$ following a specific bootstrap resampling scheme.
 - (b) Calculate a bootstrap sample $\ln(WA_{it}^b) = \widetilde{\delta} W_{it}^b + \widetilde{\epsilon_{it}}^b$, where $W_{it}^b = (\ln(\widetilde{WA_{it-1}})^b, \widetilde{IRA_{it}}^b, \ln(\widetilde{Z_{it}})^b)$.
 - (c) Obtain the LSDV estimator $\widetilde{\delta}^b = (\gamma^b, \beta_1^b, \beta_2^b) = (\widetilde{W_{it}^b}' \widetilde{W_{it}^b})^{-1} \widetilde{W_{it}^b} \ln(\widetilde{WA_{it}})^b$.
3. Compute the mean of the LSDV estimator $\widetilde{\delta}^b$ over the B bootstrap samples as $\widetilde{\delta}^b = \frac{\sum_j^B \delta_j(\widetilde{\delta})}{B}$.

To test Hypothesis 2, we replace the *IRA* variable in Equation (2) by *IRAYears* and its square:

$$\ln(WA_{it}) = \alpha_i + \gamma \ln(WA_{it-1}) + \beta_1 IRA_{it} + \beta_2 IRA_{it}^2 + \beta_3 \ln(Z_{it}) + \epsilon_{it} \quad (8)$$

Moreover, we extend our analysis by incorporating ideology variables in Equation (2) to explore whether access to safely managed water is associated with the duration of right-wing (*yearsright*) or left-wing (*yearsleft*) parties in office over multiple time periods. Additionally, we investigate whether long-run governments may influence the impact of IRAs following Hypotheses 3 and 4:

$$\begin{aligned} \ln(WA_{it}) = & \alpha_i + \gamma \ln(WA_{it-1}) + \beta_1 IRA_{it} + \beta_2 yearsleft_{it} + \beta_3 yearsright_{it} + \\ & \beta_4 yearsleft_{it} \times IRA_{it} + \beta_5 yearsright_{it} \times IRA_{it} + \beta_6 \ln(Z_{it}) + \epsilon_{it} \end{aligned} \quad (9)$$

Equations (8) and (9) are also estimated using LSDV and implementing the bootstrap procedure described above.

6 Results and discussion

The results from the estimation of the access to safe water equation are reported in Table 3. Leveraging a log-log model, we present results that can be intuitively interpreted in terms of percentages. First, we consider Hypothesis 1, i.e., we test whether establishing an *IRA* has a positive effect on access to water in LAC. The results in Column (1) show that the coefficient of *IRA* is, as expected, positive and significant. Thus, we do not reject Hypothesis 1 as we find evidence of the association between *IRA* and access to water. Specifically, the share of the population with access to safely managed drinking water in LAC countries increases by about 15% with the establishment of an *IRA*. Therefore, our findings, in contrast to those obtained by Estache et al. (2009), do suggest that the presence of an *IRA* is significantly associated with improvements in water access. Contradictory results may be attributed to different reasons. For example, the structure of the database considered. Our study utilizes a dynamic panel covering the period 2000-2020, whereas Estache et al. (2009) observed access to water in the considered countries for two years: 1990 and 2002. It is worth noting that, in 1990, only 1 out of 115 countries had established an *IRA* in the water sector, while in 2004; this number increased to 23 out of 120 countries (Estache et al., 2009). Another possible reason could be the way water access is assessed, as they focused on improved water sources, while this paper focuses on safely managed water. That is, given that improved water sources also considers basic and limited water access, the effect of the *IRA* may not be fully capture. Moreover, Estache et al. (2009) covered a wide range of developing countries, while the current study only focuses on a specific region. Differences could be attributed to regional variations, highlighting the need to investigate whether IRAs perform differently in relation to water access across geographical regions.

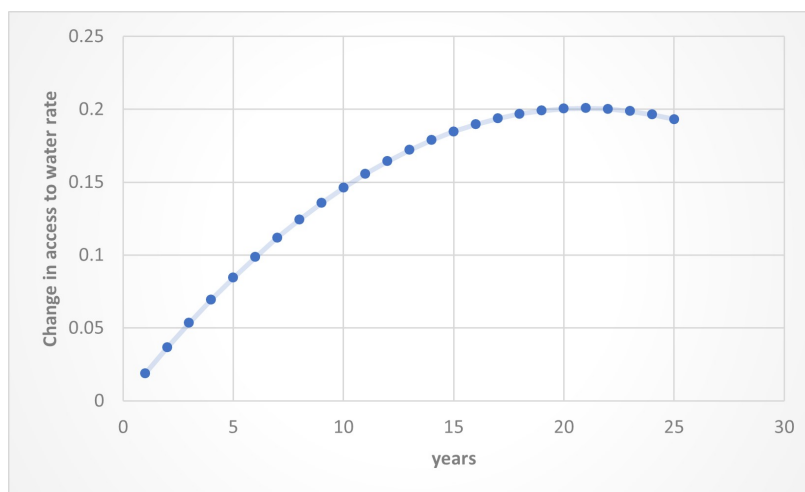
Furthermore, it must be pointed out that the studies cover periods with substantially different political approaches to water access (García-Rubio, López-Ruiz, and González-Gómez, 2019). In the global agenda, advancing universal coverage started to be a political goal with the Millennium Development Goals (MDGs) set in 2000, where countries aimed to halve the proportion of people without access to improved drinking water services by 2015. This commitment was strengthened with the recognition of the human right to water in 2010 and the goal to achieve universal water access by 2030 as part of SDG 6. This political shift in the global agenda is believed to have been determinant in the way states and institutions drive their policy goals and can partially explain differences between current and Estache et al. (2009) results.

Therefore, the absence of prior studies analyzing the impact of *IRA* on access to safely managed water limits our ability to assess external validity. As previously noted, the effect of *IRAs* on the water and sanitation sector was analyzed by Barbosa (2012), who, in examining the regulatory agency's impact on the Brazilian water sector, suggested that experience, scope and specialization of the agency do not unequivocally stimulate improvements in provider performance. Moreover, Iwanami and Nickson (2008) found

that the water users in Jakarta perceived the creation of an IRA as ineffective in enhancing service for customers. Nevertheless, our results align with findings from the energy sector in developing countries, highlighting the positive impacts of IRA on access improvements (Imam et al., 2019a,b; World Bank, 2017).

Next, we test Hypothesis 2, whether IRAs impact on water access strengthens over time and it reaches a plateau. Our results show that the number of years since the establishment of an IRA (*IRAYears*) has a positive and significant effect on access to safely managed water, and the squared of this variable (*IRAYears2*) has a negative and significant effect. That is, we do not reject Hypothesis 2. The overall effect on access to safely managed water at different time periods is shown in Figure 3, in which the change in access to water rate increases every year, reaching its maximum impact at around 20 years after the establishment of the IRA. Our findings are consistent with those of Andrés et al. (2013), who demonstrated that the experience of the IRA, measured by the number of years since its establishment, is positively associated with enhancements in coverage and other performance metrics of utilities. Additionally, our results corroborate the conclusions of Cubbin and Stern (2004), who, in their analysis of the energy sector, indicated that the effectiveness of regulation tends to increase with the maturity of the regulatory body. In the energy sector, Imam et al. (2019a) found that the peak occurs after 15 years. One possible explanation for this difference might be due to the natural monopoly features of water services, which can also explain the relatively slower and more incremental improvements observed in response to the establishment of IRAs compared to more competitive sectors such as telecommunications (Andrés et al., 2013). Since water utilities are typically decentralized and face minimal competition, the primary drivers for improvement come from regulatory pressures rather than market competition.

Figure 3: Influence of IRA on water access over time



Source: authors own elaboration.

In this regard, the age of the IRA could be an additional factor explaining why our results do not align with those of Estache et al. (2009), given that their study spans a period of high regulatory activity, and

their estimation strategy measures the average effect of IRAs, the time period may not have been long enough to capture a significant effect.

Last, we consider Hypotheses 3 and 4. In Column (3) we show the results when we include the variables related to ideology and we observe that the coefficient of *IRA* remains significant and relatively unchanged. As explained in Section 4, we consider the number of years a left or a right party has been consecutively in office (*yearsleft* and *yearsright*, respectively), to analyze the influence of ideology on access to safely managed water, and their interactions with the *IRA* indicator, to capture whether left-wing or right-wing governments may interfere with the *IRA*. The estimated coefficients for these variables are not statistically different from zero, with the exception of that of *yearsleft*, which is negative and significant. That is, an additional year of a left-wing government is associated with a 0.258% lower access to safely managed water. Thus, Hypothesis 3 is rejected, challenging the conventional belief that left-wing governments spend more and tend to focus on social issues. Given the existing literature, the results were unexpected. Despite its modest impact, further investigation of this gap would be intriguing. [Beasley-Murray, Cameron, and Hershberg \(2010\)](#) and [Terhorst, Olivera, and Dwinell \(2013\)](#) emphasize that, despite claims of left-wing governments to promote equality and reshape power dynamics, water systems in LAC are rooted in traditional power structures and problematic accumulation models, supporting the idea that a radical politics of mass mobilization is essential for advancing social change in Latin America. Additionally, recent evidence indicates that right-wing administrations such as Piñera or Macri did not pursue privatization or significant spending cuts. Instead, both administrations facilitated policy drift in some sectors and marginal expansion in others. These outcomes can be explained by policy legacies and the strength of the opposition ([Niedzwiecki and Pribble, 2018](#)).

However, access to safely managed water is not significantly influenced by the extent to which a country has been governed by a right-wing party in multiple past time periods, and there exists no significant interference of long-run left-wing or right-wing governments on the effect of *IRA* on access to safely managed water. Our results contradict those of [Imam et al. \(2019a\)](#) who find no significant effect of left-wing governments on access to electricity rates in Sub-Saharan Africa, but they find a positive and significant effect of right-wing governments. Moreover, they find interference of left-wing governments on *IRA*'s functions. It is important to note that, differently from the electricity sector, the water and sanitation sector is extremely decentralized, and, therefore, long-run ideology in local governments may have a stronger influence on access to safely managed water. For example, as discussed by [Tamayo, Barrantes, Conterno, and Bustamente \(1999\)](#), the composition of service provider companies' boards in Peru is determined by provincial and district mayors. The allocation of votes follows the pattern of existing connections, wherein mayors in districts with substantial coverage lack motivation to extend services to districts with lower coverage due to the potential diminution of their relative influence. Nevertheless, as indicated in the data section, our ideology variable does not encompass the ideology of mayors but rather that of the na-

tional government. This limitation is imposed by the study's focus on the hypothetical politicization of IRAs, and it should be noted that local governments lack the authority to define the composition or policy guidelines of IRAs. The influence of ideology and political motivations on local governments' decisions regarding urban water service management has been well-documented (Picazo-Tadeo, González-Gómez, Wanden-Berghe, and Ruiz-Villaverde, 2012). Even when considering the longevity of left and right parties in government (Beuve and Le Squeren, 2016), ideology remains a powerful driver. However, the focus of our study is related to the growing debate and concern regarding politicization of IRAs, and our results suggest that, at least concerning the goal of expanding access to safely managed water, independent water agencies are not influenced by the political party in power.

The coefficients of the control variables generally take the expected signs, when significant, and are consistent across models. The coefficient of $\ln(gdp_pc)$ is positive across the three models, and significant in the regressions shown in Columns (1) and (3). That is, as expected, there is a positive association between development and water access, as has been previously found in the literature (García-López et al., 2023). While the proportion of population living in urban areas does not seem to have a significant effect in most of the models, with its coefficient being negative and significant only in Column (2), population density is associated with higher access rates. This result is in line with previous research finding greater ease of providing water access in areas with higher population density (Chaudhuri and Roy, 2017; Luh, Baum, and Bartram, 2013; Pullan, Freeman, Gething, and Brooker, 2014). Lastly, corruption does not seem to have had a statistically significant impact on access rates, in line with previous results Estache et al. (2009).

Table 3: Estimation results

	(1)	(2)	(3)
	$\ln(WA)$	$\ln(WA)$	$\ln(WA)$
$\ln(WA_{t-1})$	0.229*** (4.57)	0.139*** (5.00)	0.190*** (4.07)
IRA	0.147*** (8.57)		0.140*** (8.35)
IRAYears		0.0192*** (25.99)	
IRAYears2		-0.000459*** (-20.15)	
yearsleft			-0.00257* (-1.99)
yearsright			0.000733 (0.61)
leftIRA			0.00222 (1.34)
rightIRA			-0.00196 (-1.57)
$\ln(gdp_pc)$	0.0679*** (4.75)	0.00953 (1.19)	0.0493*** (3.59)
$\ln(pop_density)$	0.898*** (9.15)	0.998*** (18.23)	1.068*** (10.02)
$\ln(urban)$	-0.00842 (-0.16)	-0.0758* (-2.52)	-0.0292 (-0.49)
$\ln(corrupt_public)$	-0.0361 (-1.96)	-0.00623 (-0.64)	-0.0197 (-1.08)
N	242	242	231
t statistics in parentheses			
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$			

7 Conclusion and policy recommendations

This paper investigates whether the presence of IRAs is associated with higher access to safely managed water in LAC countries. Additionally, we explore the potential influence of political ideology on this relationship. Our analysis utilizes a panel dataset comprising data from 12 LAC countries, covering the period 2000-2022. Building upon [Estache et al. \(2009\)](#), our study extends the time horizon and considers nonlinear effects of IRAs on water access. Furthermore, we examine the impact of political interference in IRAs.

Our findings reveal that the establishment of an IRA is positively associated with approximately 15% higher access to safely managed water. Notably, this effect is not linear. Specifically, the influence of an IRA on water access strengthens over time, reaching a peak at approximately 21 years. It is essential to recognize that the average age of IRAs for those countries in our sample which had established one by 2022 is around 25 years. This longevity may partly explain the stagnation noted by [WHO UNICEF \(2023b\)](#). It is important to recognize the structural limitations imposed by the natural monopoly features of water

services when comparing regulatory outcomes across different sectors. While IRAs in the energy and telecom sectors often leverage market competition to drive improvements, water sector IRAs must rely more heavily on regulatory mechanisms to foster efficiency and ensure equitable access (Andrés et al., 2013). Policymakers should, therefore, tailor their expectations and strategies accordingly, focusing on enhancing regulatory capacity and governance within this monopolistic framework.

Contrary to our initial hypothesis, which posited that left-wing governments would be associated with higher access to safely managed water, our findings reveal a surprising trend. Countries governed by left-wing administrations, compared to centrist governments, over extended periods exhibit lower access rates. Specifically, each additional year in office corresponds to a 0.258% lower access. While this paper discusses potential explanations for this unexpected result, further research is imperative.

Importantly, we find no evidence of long-run governments, regardless of their ideological leanings, interfering with the impact of IRAs on water access. This result underscores the importance of IRAs maintaining operational autonomy from elected politicians. This research offers a timely contribution to ongoing policy discussions on governance and regulatory effectiveness in the water sector. Future research could investigate whether these dynamics are also present in IRAs that do not operate nationwide or explore the effects when federal and regional governments differ ideologically. Case-based studies or controlling for variables such as physical geography, which can significantly influence infrastructure investment (Min, 2008), or the interaction between privatization and IRA, would be interesting avenues for further research.

While information on access to safely managed water is still needed for several LAC countries to assess whether and to which extent our results can be generalized further, this paper significantly advances our understanding of the intricate relationship between IRAs and water access in the LAC region. It underscores the indispensable role of autonomous regulatory agencies, emphasizing the need to avoid a scenario of “government regulating government”. Such an approach risks pushback on regulatory efforts or the erosion of regulatory instruments due to political incentives (Peci, D’Assunção, Holperin, and de Souza, 2017). Ultimately, achieving the SDG #6 hinges on the effectiveness of these agencies.

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A Appendix

Table 4: Correlation matrix dependent and explanatory variables

	$\ln(WA)$	ΔWA
<i>IRA</i>	0.555***	0.189**
<i>IRAYears</i>	0.588***	-0.191**
<i>IRAYears2</i>	0.522***	-0.279***
<i>yearsleft</i>	0.502***	-0.142*
<i>yearsright</i>	-0.131*	0.274***
<i>leftIRA</i>	0.529***	-0.121
<i>rightIRA</i>	-0.0696	0.282***
<i>ln(gdp_pc)</i>	0.423***	-0.628***
<i>ln(pop_density)</i>	0.130*	-0.0749
<i>ln(urban)</i>	0.451***	-0.575***
<i>ln(corrupt_public)</i>	-0.794***	0.418***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$