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ENVIRONMENTAL ISSUES: REPORTS ON THE MODERATION OF RE-ELECTION IN FRONTLINE POLITICS

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ABSTRACT

The article aims to analyze the moderating effect of re-election on the relationship between environmental spending behavior and forward-looking policies (health, education, safety, infrastructure) in Brazilian municipalities, filling a gap by examining how the quest to remain in power influences the manipulation of spending to improve the image of managers, with implications for expenditure selection. The analysis covered 46,881 observations from 5,007 Brazilian municipalities from 2007 to 2021, employing panel data regression to examine how environmental spending affects different categories of frontline spending. The results reveal an association between environmental spending and spending on education, suggesting budgetary adaptations to address environmental issues, while the moderation of re-election indicates a management more influenced by the scarcity of resources than by opportunistic pursuit. In addition, other models contradict this relationship, emphasizing the perceived impact of spending on health and safety on the political image of managers. The preference for municipal security over environmental spending for re-election purposes, together with the stability of infrastructure spending over time, suggests a possible underutilization of these resources in times of crisis in the Brazilian context.

Keywords: political cycles, front-running policies, re-election strategies, environmental spending.

Edited in Portuguese and English. Original version in Portuguese.

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1 INTRODUCTION

Population growth is linked to ecological deterioration and environmental conservation. In addition to affecting the environment through degradation and increased demand for resources, population growth makes it more difficult to maintain human well-being (Mora & Sale, 2011; Mora, 2014). Addressing these complex human needs appears to require the efforts of international organizations that consider both issues together (Walker *et al.*, 2009; Mora, 2014). Studies examining the literature on this relationship have shown that, although 70% of articles explicitly identify population growth as a factor that exacerbates social and environmental problems, these issues still appear to receive insufficient attention in government decision-making (Mora 2014; Hu *et al.*, 2020).

To prevent one issue from being treated as less important than the other, Hu *et al.* (2020) argue that political institutions are responsible for formulating regulations. They also contend that incorporating any economic system into a political model requires consideration of the conflicts of interest that political decisions may create for environmental and social issues, beyond their economic implications. In public environmental management specifically, democracy receives considerable attention because public funds may be used for political purposes at opportune moments (List & Sturm, 2006; Hu *et al.*, 2020).

In democracies, environmental groups gain the space and influence to shape public opinion during election periods, given the need to comply with the law (Payne, 1995; Hu *et al.*, 2020). At the same time, public officials have short planning horizons and face political incentives to satisfy party affiliations, alongside budgetary constraints. In this context, environmental policies may be relegated to a secondary position in strategies aimed at winning elections (Hu *et al.*, 2020; Halac & Yared, 2022).

When devising electoral strategies, public officials act on the demands attributed to the population, aligning the package of benefits they offer with those likely to have the greatest visibility and influence among voters (Bartoluzzio & Anjos, 2020). From this perspective, considering the main areas of population concentration and growth within municipalities, an official seeking to gain or retain office may select the demands most compelling to voters (Trojanek *et al.*, 2021). This may lead them to prioritize certain expenditures over others in pursuit of an electoral advantage (Bartoluzzio & Anjos, 2020; Halac & Yared, 2022).

The shifting of public spending priorities is a behavior anticipated by Political Business Cycle Theory, proposed by Nordhaus (1975). The theory explains how a fixed electoral calendar influences the distribution of public expenditure in light of voters' bounded rationality concerning what this study calls pioneering policies: spending on health and public safety (Mora, 2014; Carvalho & Silva, 2011), education (Salaberry *et al.*, 2022), infrastructure (Oliveira *et al.*, 2023), and the environment (List & Sturm, 2006; Pacca *et al.*, 2021). Environmental spending, the focus of this research, encompasses public actions to preserve, improve, and restore environmental quality conducive to life (Sabra, 2022).

However, research has reported differing patterns in the allocation of municipal public resources to environmental and pioneering expenditures during election periods. This allocation may also be used to support the reelection of mayors or particular political coalitions in different institutional settings. In Flemish municipalities, for example, Ashworth *et al.* (2006) found a reduction in taxes related to so-called green issues as elections approached. Similarly, Fankhauser *et al.* (2015) extended the analysis to the national level and showed that climate change proposals face greater difficulty in gaining approval in the periods preceding municipal elections. In China, Cao *et al.* (2019) examined mayors' propensity to relax environmental controls during periods when the national government evaluates their performance. Likewise, D'Amato *et al.* (2019) found an increase in permits for infrastructure construction in Italy in the year before elections.

The formulation of these environmental practices and policies takes into account relevant economic factors, such as agricultural expansion, logging, and infrastructure development (Busch

& Ferretti-Gallon, 2017; Ruggiero *et al.*, 2021). In Brazil, particularly in the Amazon forest region, electoral dynamics contributed to an increase in the deforested area. Pailler (2018) identified agricultural expansion as the main cause of the reduction in the region's forest cover, while emphasizing that the relaxation of policing and reduced enforcement against logging during election periods are significantly associated with this phenomenon. The findings reported by different researchers demonstrate public officials' ability to manipulate the allocation of public spending to promote their image through the strategic selection of expenditures (Bartoluzzio & Anjos, 2020; Halac &Yared, 2022).

Considering the selective allocation of investment as a reelection strategy and the political cycle perspective, which addresses the redistribution of expenditure according to public officials' interests and their intention to remain in power (Ongan *et al.*, 2023), the overall objective of this study is **to analyze the moderating effect of reelection on the relationship between environmental spending patterns and pioneering policies in Brazilian municipalities.**

The decision to include all Brazilian municipalities in the analysis reflects the concentration of human and economic activity fostered by urban centers, which makes the redistribution and allocation of public resources more visible and consequential to residents (List & Sturm, 2006; Bugarin & Marciniuk, 2017; Bartoluzzio & Anjos, 2020). The study also aims to map how spending on pioneering policies and the environment is used as an instrument for reelection in municipalities of different sizes across all geographic regions of Brazil.

This scope takes into account the importance of regional differences in the intensity of environmental spending, for example, in less industrialized regions or those with greater agricultural activity, and their effects on municipal budget planning in Brazil. The study also discusses the tension between basic human needs and attention to the environment when these demands compete, as well as the prioritization of public spending as a strategy for securing electoral benefits at the municipal level. In doing so, it contributes to improving municipal management practices and planning tools.

To guide readers through the ideas discussed in this study, the article is divided into five sections: (i) the introduction, which places the study in the context of global and contemporary events; (ii) the theoretical framework, which presents the concepts, competing arguments, and research hypotheses; (iii) the methodological procedures, which describe the statistical methods used to ensure the validity of the analyses; (iv) the presentation and discussion of the results, which sets out the inferences and interpretations based on the statistical findings; and (v) the conclusions, which summarize the main findings and clarify the principal challenges to completing the study.

2 THEORETICAL BACKGROUND

2.1 Political cycles and spending priorities

Nordhaus (1975) proposed Political Business Cycle Theory as a way to understand the factors that motivate public officials' actions in a democratic system. The theory also examines how officials may exploit voters' bounded rationality to improve their prospects of reelection and keep their party in power, at times at the expense of the office's social responsibilities. These relationships prompted analyses of the divergence between the interests of public officials and those of the population, revealing that certain policies receive greater priority during election periods (Hibbs, 1977).

Rogoff (1990), in turn, examined how both public officials and voters seek to maximize their utility. He developed a model in which assessments of government transfers and consumption generate information asymmetry concerning officials' competence and voters' expectations. He also suggests that political cycles are effective social mechanisms through which voters acquire information and become less unaware of government practices.

Because Brazil's democratic system is relatively recent, its population may not detect electoral opportunism. Officials seeking reelection may therefore manipulate electoral outcomes

in various ways, including by shaping public policies to appeal to voters' interests (Rocha *et al.*, 2021). Such behavior prompted studies including that of Sakurai and Menezes-Filho (2011), which found that public spending increases in line with Brazil's electoral calendar. A fixed election schedule creates opportunities to manipulate spending on measures that are visible in the short term, the period most relevant to voters' recollections. Infrastructure spending is a clear example: it produces tangible results for local residents and can influence the popularity of officials seeking reelection (Bartoluzzio & Anjos, 2020).

2.2 Development and Presentation of the Hypotheses

The prioritization of what this study calls pioneering expenditure over environmental spending is directly linked to the needs of the population. As urban centers grow, supplying municipalities with food creates a conflict between the agricultural expansion needed to meet the basic need for food and efforts to preserve land for biodiversity conservation. This places human development at odds with the preservation of the biosphere (Mora, 2014).

From the perspective of meeting needs arising from population growth, factors such as employment also shape public officials' concerns, since technological advances and the depletion of natural resources can lead to budget deficits (Mora, 2014). Mora explains how the provision of public services such as public safety, education, and health care affects expenditure and, consequently, how local residents perceive the incumbent official. Delgado (2022) examined the budgetary impact of assigning municipalities responsibility for public safety, noting substantial growth in the structures and policies of municipal administrations, including the creation or expansion of municipal guards, departments, and councils.

These dynamics were already described by Nordhaus (1975), who argued that candidates placed far greater emphasis on favorable economic conditions, abandoning less popular policies during election periods and returning to those lower-priority policies after winning. According to Post and Kuipers (2022), smaller municipalities tend to focus more on investments in health and education, such as providing quality public primary education or treating piped water because of pollution resulting from aggressive industrialization in the region.

Post and Kuipers's (2022) discussion of easier access to lower-quality public services in small municipalities than in large urban centers raises the question of how local demands that promise better electoral outcomes may affect spending on environmental practices. In short, environmental spending competes for budgetary resources with pioneering policies (health, education, public safety, and infrastructure), which have strong electoral appeal and differ in how readily voters perceive their effects. Environmental spending is therefore expected to constrain the fulfillment of demands for pioneering policies, although the extent of this effect may vary across spending areas. Accordingly, the following hypothesis is proposed:

H_1: Increased environmental spending has a significant negative effect on spending on pioneering policies.

Even when the population's basic needs are unaffected, public officials' actions can influence the effectiveness of environmental policy, as demonstrated by Kalabokidis *et al.* (2008) and Skouras and Christodoulakis (2010). Their studies examined Greek municipalities and found a higher incidence of wildfires during election periods in those at risk of forest fires. This pattern is driven by the issuance of permits for the use of and construction on public land. A similar pattern has been observed in Brazil's Atlantic Forest region, where Pailler (2018) describes how reelection incentives contribute to increased deforestation, and in Indonesia, where illegal logging increases substantially around elections (Burgess *et al.*, 2011).

Similarly, Post and Kuipers (2022) described how public demand can prompt officials to provide access to a service without necessarily ensuring its quality, allowing them to promote that

access in future election campaigns. The authors also examined municipality size. They stated that, in smaller municipalities, low levels of urbanization favor investment in basic health services and educational facilities because these are relatively inexpensive and highly visible to local residents.

Large municipalities require a broad range of public services because of the adverse externalities of urban growth. Officials in large cities therefore tend to prioritize improving access to existing services over introducing new benefits (Post & Kuipers, 2022; Mora, 2014). The need to create or improve access to public services in response to population growth is linked to the use of natural resources and the release of pollutants into ecosystems. Yet decisions about the allocation of public resources reflect how efficiently residents perceive those resources to be used, a decisive factor in retaining power in hierarchical political systems (Post & Kuipers, 2022; Mora & Sale, 2011).

As elections approach, public officials tend to focus more closely on issues with greater visibility and popular appeal. It is therefore reasonable to expect that the pursuit of reelection will intensify the diversion of resources away from the environment. This moderating effect is also expected to be more pronounced for policies that yield more immediate electoral returns, indicating that its strength will vary among the pioneering policies examined here, as may be the case for public safety. Accordingly, the second hypothesis is proposed:

H_2: Reelection has a significant negative moderating effect on the relationship between increased environmental spending and spending on pioneering policies.

3 METHODOLOGICAL PROCEDURES

3.1 Sample and Data Collection

The data for this study cover a broad range of fiscal, economic, and demographic variables for Brazil's 5,568 municipalities over the fifteen-year period from 2007 to 2021. To represent pioneering policies, the shares of spending on health, education, public safety, urban development, and housing in total municipal current expenditure were selected, allowing the relative weight of these expenditures to be assessed. The share of spending on environmental management was selected as the variable of interest. These and other fiscal variables were collected from the Finanças do Brasil (Finbra) and Sistema de Informações Contábeis e Fiscais do Setor Público Brasileiro (Siconfi) databases. Demographic and economic variables were obtained from the Instituto Brasileiro de Geografia e Estatística (IBGE).

The study population comprises Brazil's 5,568 municipalities and 83,520 observations over the period from 2007 to 2021. For the purposes of the study, the sample was restricted to observations with complete data for all variables, resulting in 46,881 observations from 5,007 municipalities and an unbalanced panel. To address potential outliers, the data were winsorized at the 1% level. This technique replaces extreme values with the values at the 1st and 99th percentiles, reducing their influence while retaining the observations (Wooldridge, 2016), rather than removing them from the dataset. This approach was chosen in view of the characteristics of Brazilian municipalities, most of which are small or medium-sized.

A methodological note is warranted regarding the exclusion criterion: the reduction from 83,520 potential observations (5,568 municipalities × 15 years) to 46,881 observations in the final sample results from the requirement that data be available simultaneously for every variable in the model, particularly the expenditure categories drawn from Siconfi/Finbra and the electoral variables. The principal reason for these exclusions is that some municipalities did not report data for particular fiscal years, resulting in an unbalanced panel.

3.2 Variables, Econometric Models, and Data Analysis

The study variables are listed in Table 1 and comprise the dependent variables, the independent variables of interest, and the control variables.

Table 1
Study Variables

Dependent variable			
Variable	**Description**	**Operationalization**	**References**
Health expenditure (Saúde)	Shows the proportion of municipal current expenditure spent on health	Health and basic sanitation expenditure paid during the fiscal year / Total current expenditure paid during the fiscal year	Sousa *et al.* (2020)
Education expenditure (Educ)	Shows the proportion of municipal current expenditure spent on education	Education expenditure paid during the fiscal year / Total current expenditure paid during the fiscal year	Sousa *et al.* (2020)
Public safety expenditure (Seg)	Shows the proportion of municipal current expenditure spent on public safety	Public safety expenditure paid during the fiscal year / Total current expenditure paid during the fiscal year	Carvalho & Silva (2011)
Urban development and housing expenditure (Urbhabit)	Shows the proportion of municipal current expenditure spent on urban development and housing	Urban development and housing expenditure paid during the fiscal year / Total current expenditure paid during the fiscal year	Sousa *et al.* (2020)
Independent variables			
Variables of interest			
Variable	**Description**	**Operationalization**	**References**
Environmental management (GestAmb)	Shows the proportion of municipal current expenditure allocated to environmental management	Environmental management expenditure / Total current expenditure paid during the fiscal year	List & Sturm (2006); Pacca *et al.* (2021)
Reelection (Reel)	Indicates whether the mayor was reelected	Dummy variable: (1) mayor reelected; (0) mayor not reelected	Rocha *et al.* (2021)
Control variables			
Variable	**Description**	**Operationalization**	**References**
Total current expenditure (Dtotal)	Shows municipal current expenditure as a proportion of municipal GDP	Total current expenditure paid during the fiscal year / Municipal gross domestic product for the fiscal year	Neduziak e Correia (2017); Sousa *et al.* (2020)
GDP adjustment (Comppib)	Shows transfers received as compensation for natural	Financial compensation for the exploitation of natural resources / Municipal GDP for the fiscal year	Marques *et al.* (2026)

	resource extraction as a proportion of municipal GDP		
Same party as the president (App)	Captures whether the mayor belongs to the same political party as the president of Brazil	Dummy variable: (1) if the mayor belongs to the same party as the president; (0) otherwise	Baldissera *et al.* (2019)
Same party as the governor (Apg)	Captures whether the mayor belongs to the same political party as the state governor	Dummy variable: (1) if the mayor belongs to the same party as the governor; (0) otherwise	Baldissera *et al.* (2019)
Gross domestic product per capita (Pibper)	Measures the total value of all final goods and services produced in a municipality during a year, relative to its number of inhabitants	Gross domestic product per capita	Silva & Crisóstomo (2019)
Number of inhabitants (Pop)	Shows the number of inhabitants of the municipality	Natural logarithm of the number of inhabitants at the end of the fiscal year	Sakurai & Menezes-Filho (2011)

Source: Prepared by the authors.

To analyze the moderating effect of reelection on the relationship between environmental spending patterns and pioneering policies in Brazilian municipalities, the following model was developed:

$$\begin{aligned} Health_{it}, Educ_{it}, Seg_{it}, Urbhabit_{it} &= \beta_0 + \beta_1 GestAmb_{it} + \beta_2 Reel * GestAmb_{it} + GDPper_{it} + \beta_4 Dtotal_{it} \\ &+ \beta_5 Comppib_{it} + \beta_6 Pop_{it} + \beta_7 APG_{it} + \beta_8 APP_{it} \\ &+ \beta_9 Pp1_{it} + \beta_{10} Pp2_{it} + \beta_{11} Mp_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

Where: $Health_{it}$ = proportion of municipality i's expenditure on health in period t; $Educ_{it}$ = proportion of municipality i's public expenditure allocated to education in period t; Seg_{it} = roportion of municipality i's expenditure on public safety in period t; $urbhabit_{it}$ = proportion of municipality i's expenditure on urban development and housing in period t; $GestAmb_{it}$ = proportion of municipality i's public expenditure allocated to environmental management relative to its total current expenditure in period t; $Reel * GestAmb_{it}$ = interaction between the reelection variable and GestAmb for municipality i in period t; $GDPper_{it}$ = gross domestic product *per capita* of municipality i in period t; $Dtotal_{it}$ = total current expenditure of municipality i in period t; $Compgdp_{it}$ = transfers received as compensation for natural resource extraction as a proportion of municipality i's GDP in period t; Pop_{it} = number of inhabitants of municipality i in period t; APG_{it} = party alignment between the mayor and the governor of municipality i's state in period t; APP_{it} = party alignment between the mayor and the president in periodt; $Pp1_{it}$= municipalities classified as small, category 1, in period t; $Pp2_{it}$ = municipalities classified as small, category 2, in period t; Mp_{it} = municipalities classified as medium-sized in period t.

To test the study hypotheses, four multivariate models were estimated. The treatment of the reelection variable in Equation (1) warrants clarification. The model retains the variable of interest, GestAmb, as a main effect and tests the moderating effect of reelection through the Reel × GestAmb interaction term, consistent with the study's focus on environmental spending patterns and electoral moderation. The analysis used panel data methods. First, the most appropriate estimator for each of the four models was identified by considering pooled, fixed-effects, and random-effects models (Fávero & Belfiore, 2017). The observations in each model were subjected to the Breusch–Pagan Lagrange multiplier (LM) test for this purpose.

Regarding the choice between fixed and random effects, the Hausman test is recognized as the conventional procedure (Wooldridge, 2016; Fávero & Belfiore, 2017). However, its application becomes technically inconsistent in models containing time-invariant explanatory variables, such as the regional (Região) and municipality-size (Pp1, Pp2, and Mp) dummy variables, which are central to this study's analytical design. Under fixed effects, these variables would be absorbed by the individual intercepts, preventing estimation of their coefficients and compromising the substantive interpretation of results by region and municipality size. Given this limitation, random effects were selected on the basis of the Breusch–Pagan LM test, whose results supported this estimator for all four models.

The assumptions underlying multivariate regression were then assessed to determine whether the models were subject to bias. This assessment included tests of multivariate normality, heteroskedasticity in the residuals, serial autocorrelation, and multicollinearity among the independent variables. Statistical procedures included the Breusch–Pagan test for heteroskedasticity, the Wooldridge test for first-order serial autocorrelation, and variance inflation factors (VIFs) for multicollinearity. This assessment of the assumptions helped establish the reliability and validity of the results obtained from the multivariate panel data regressions.

4 RESULTS AND DISCUSSION

4.1 Descriptive Analysis

Table 2 presents descriptive statistics for the study variables to provide an overview of their distributions.

Table 2
Descriptive Statistics

Variables	Mean	Standard deviation			Minimum	Maximum	Obs.
		O	B	W			
Health	0.26825	0.05664	0.04642	0.03311	0.13833	0.44127	46,881
Educ	0.32674	0.09418	0.09179	0.03737	0.15717	0.61120	46,881
Seg	0.27443	0.45856	0.40266	0.37786	0.00002	1.16895	26,380
Urbhabit	0.39150	0.70786	0.63531	0.33494	0.00000	2.28165	46,881
GestAmb	0.00924	0.01331	0.00999	0.00841	0.00001	0.07067	46,881
Comppib	12,5076	1.4355	1.2608	0.5946	10.4627	17.4489	46,881
Dtotal	156,9382	89,9567	93,5435	23.3674	35.1890	431,6899	46,881
Pop	9.6272	1.2277	1.1569	0.0555	7.4507	13.2103	46,881
GDPper	21.1216	18.7337	15.9821	9.5807	3.0128	115,7114	46,881

Variables	AF of observations (FA)	RF%	Observations not included in AF	RF%	Obs.
Reel	10,275	21.92%	36,606	78.08%	46,881
APP	7.730	16.49%	39.151	83.51%	46,881
APG	5.501	11.73%	41,380	88.27%	46,881

Notes. $Health_{it}$ = proportion of municipality i's expenditure on health in period t; $Educ_{it}$ = proportion of municipality i's public expenditure allocated to education in period t; Seg_{it} = roportion of municipality i's expenditure on public safety in period t; $urbhabit_{it}$ = proportion of municipality i's expenditure on urban development and housing in period t; $GestAmb_{it}$ = proportion of municipality i's public expenditure allocated to environmental management relative to its total current expenditure in period t; $Reel * GestAmb_{it}$ = interaction between the reelection variable and GestAmb for municipality i in period t; $GDPper_{it}$ = gross domestic product *per capita* of municipality i in period t; $Dtotal_{it}$ = total current expenditure of municipality i in period t; $Compgdp_{it}$ = transfers received as compensation for natural resource extraction as a proportion of municipality i's GDP in period t; Pop_{it} = number of inhabitants of municipality i in period t; APG_{it} = party alignment between the mayor and the governor of municipality i's state in period t; APP_{it} = party alignment between the mayor and the president in periodt t; O: *Overall*; B: *Between*: W: *Within*; Obs.: Observations; AF: absolute frequency of observations; NAF: observations not included in AF; RF%: relative frequency expressed as a percentage.
Source: Study data (2026).

Analysis of the study's dependent variables showed the following means and standard deviations for expenditure: health (0.27; ±0.06), education (0.33; ±0.09), public safety (0.27; ±0.46), and urban development and housing (Urbhabit) (0.39; ±0.71). These figures show the substantial share of total current expenditure devoted to areas considered priorities by the population.

The maximum values recorded in some municipalities for public safety (1.17) and urban development and housing (2.28) exceed total current expenditure. This suggests that these municipalities face critical challenges, such as high crime rates and a need for investment in public safety infrastructure or urban development. Such expenditure, which may be financed through capital revenues, is directly related to municipalities' capacity to invest in infrastructure in these areas.

In contrast to the substantial share devoted to priority areas, expenditure on environmental management (GestAmb) had a mean of just 0.01 and a standard deviation of ±0.02. This finding points to the low priority given to environmental issues in Brazil: even the municipality with the highest share allocated only 0.07 of its total current expenditure to this area. This situation raises questions about the need for pioneering policies to promote recovery and stimulate local and regional economic development in a country marked by regional disparities stemming from its colonial history.

4.2 Inferential analysis

To test the hypotheses, a multivariate regression analysis was conducted, preceded by a *Spearman* correlation test. The results showed significant correlations between the policy areas of health, education, public safety, urban development and housing and the independent variables, environmental management expenditure and reelection. This suggests that these factors may affect public budgets.

Following the correlation analysis, the Breusch–Pagan Lagrange multiplier (LM) test was applied and indicated random effects as the most appropriate estimator for all models. The assumptions concerning multicollinearity, heteroskedasticity, and serial autocorrelation were then examined. VIF values below 10 indicated no multicollinearity; however, the Breusch–Pagan and Wooldridge tests detected heteroskedasticity and serial autocorrelation. Standard errors were therefore clustered at the municipality level (Fávero & Belfiore, 2017).

Table 3 presents the results for the influence of environmental spending on policy areas in Brazilian municipalities.

Table 3
Moderating effect of reelection on the relationship between environmental spending and municipal pioneering policies

Models	**(1)**	**(2)**	**(3)**	**(4)**
Pioneering Policies	**Health**	**Education**	**Public Safety**	**Urbhabit**
GestAmb	**0.0488***	**-0.0884*****	-0.2378	0.0599
	(0.0281)	**(0.0300)**	(0.3056)	(0.3056)
Reel*GestAmb	**0.1235*****	-0.0290	**-0.9587*****	-0.3186
	(0.0338)	(0.0337)	**(0.3229)**	(0.2986)
Gdpper	0.0006***	-0.0005***	0.0021***	-0.0013***
	(0.0000)	(0.0000)	(0.0002)	(0.0004)
Dtotal	0.0000***	-0.0001***	-0.0007***	-0.0003***
	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Comppib	0.0090***	-0.0058***	-0.0472***	0.0022
	(0.0005)	(0.0005)	(0.0037)	(0.0054)
Pop	0.0036***	0.0200***	-0.0186*	-0.1731***
	(0.0012)	(0.0017)	(0.0098)	(0.0211)
APG	-0.0038***	-0.0006	-0.0138**	-0.0072
	(0.0007)	(0.0008)	(0.0068)	(0.0077)

APP	-0.0061***	0.0054***	0.0807***	-0.0014
	(0.0007)	(0.0008)	(0.0005)	(0.0100)
Pp1	0.0181***	0.0439***	0.1045***	-0.5307***
	(0.0045)	(0.0063)	(0.0324)	(0.0667)
Pp2	0.0096**	0.0422***	0.0485**	0.2817***
	(0.0038)	(0.0056)	(0.0234)	(0.0357)
Mp	0.0107***	0.0225***	0.0033	0.0639***
	(0.0035)	(0.0053)	(0.0202)	(0.0174)
Constant	0.0844***	0.1581***	1.0538***	2.3798***
	(0.0149)	(0.0198)	(0.1206)	(0.2584)
Region	Yes	Yes	Yes	Yes
Observations	46,881	46,881	26,380	46,881
Municipalities	5,007	5,007	4,395	5,007
R2 overall	0.0435	0.4140	0.0372	0.0178
R2 within	0.1249	0.0370	0.0193	0.0765
R2 between	0.0329	0.5051	0.1036	0.0178
F/Wald test	1,755.41***	4,793,41***	1,234,85***	593,62***
LM.BP	1,0e+05***	1,3e+05***	19,06***	1,4e+05***
VIF (maximum)	1,94	1,94	2,14	1,94
VIF (minimum)	1,01	1,01	1,01	1,01
Breusch-Pagan	1,208,45***	2,423,88***	294,60***	1,094,18***
Wooldridge	641,35***	122,11***	3,219,24***	1,422,81***

Notes: BP: Breusch–Pagan LM test. Models (1) through (4) present the results for the influence of environmental management expenditure on the pioneering policy areas of health, education, public safety, and urban development and housing, respectively, together with the moderating variable. All models were estimated using random effects, with standard errors reported in parentheses. The t-statistics for all models are based on heteroskedasticity-robust standard errors clustered by municipality. The symbols *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.
Source: Study data (2026).

The results in Table 3 reveal heterogeneous patterns in the relationship between environmental spending and municipal pioneering policies, requiring separate assessment of the four propositions that make up H1. H1 is tested in four independent models, one for each category of pioneering expenditure. It is supported only by Model 2 (Education), which shows a significant negative relationship between environmental and education spending (coefficient: −0.0884; p-value: < 0.000). The result suggests that an increase in the share of environmental spending is associated with a decrease in the share allocated to education in municipal current expenditure, indicating an adjustment in resource allocation consistent with limited public resources. Among the pioneering policies tested, education appears to be the category most sensitive to the budgetary pressure associated with environmental spending in Brazilian municipalities.

Model 1 (Health), by contrast, shows a significant positive relationship (coefficient: 0.0488; p-value: < 0.10). An effect is present, but its direction is opposite to that hypothesized: environmental and health spending are positively associated. This pattern suggests complementarity rather than substitution between the two expenditure categories, consistent with the links among environmental health, basic sanitation, and health surveillance within Brazil's Unified Health System (SUS).

Models 3 (Public Safety) and 4 (Urbhabit) do not show statistically significant effects (coefficients: Public Safety, −0.2378; Urbhabit, 0.0599; p-values: > 0.10 for both). These findings are inconclusive; they do not establish the absence of an effect. One possible explanation is the limited flexibility in allocating expenditure in these categories, given earmarked or mandatory commitments such as municipal guard payrolls, urban maintenance contracts, and conditional federal housing programs. Such commitments leave less scope for competition with environmental spending.

Taken together, the four models support H1 for one category (Education), show an effect in the opposite direction for another (Health), and yield inconclusive results for two (Public Safety

and Urbhabit). This heterogeneous pattern indicates that budgetary competition between environmental spending and pioneering policies varies with the institutional characteristics of each expenditure category. Like H1, H2 comprises four propositions and is assessed separately in each model. The analysis by expenditure category follows.

In Model 1 (Health), the Reel × GestAmb interaction is positive and significant (coefficient: 0.1235; p-value: < 0.01). H2 is contradicted in this category because the sign is opposite to that predicted: rather than weakening the relationship between GestAmb and health spending, reelection strengthens its positive direction. Together with the positive main effect of GestAmb on health spending, this result suggests that the complementarity between environmental and health agendas becomes stronger when mayors seek reelection. One plausible interpretation is the electoral use of environmental health as a visible achievement: initiatives with both environmental and health benefits, such as sanitation and endemic disease control, may yield greater electoral returns than exclusively environmental initiatives.

In Model 2 (Education), the interaction is not statistically significant (coefficient: −0.0290; p-value: > 0.10). H2 is therefore not supported. The negative relationship between environmental and education spending identified in the main effect appears to be independent of the reelection cycle. This finding suggests that budgetary competition between the two expenditure categories reflects a structural fiscal constraint rather than opportunistic electoral manipulation. From the perspective of political budget cycle theory, education appears insulated from the electoral cycle's short-term incentives, contrary to the expectation of budgetary flexibility derived from Nordhaus (1975).

In Model 3 (Public Safety), the interaction is negative, substantial in magnitude, and highly significant (coefficient: −0.9587; p-value: < 0.01). H2 is supported with the expected sign. This is the only category in which the moderating effect of reelection operates as predicted by political cycle theory. The result indicates that mayors seeking reelection intensify the substitution between environmental and public safety spending, consistent with the latter's high electoral visibility. Although public safety is primarily a state responsibility, municipalities have assumed a growing role through municipal guards, video surveillance, and lighting intended to improve safety. These investments can quickly produce visible results, consistent with Rogoff's (1990) account of electoral signaling and the findings of Carvalho and Silva (2011) and Bartoluzzio and Anjos (2020).

In Model 4 (Urbhabit), the interaction has the expected negative sign but is not statistically significant (coefficient: −0.3186; p-value: > 0.10). H2 is therefore not supported. This result is consistent with the finding for the main effect and reinforces the interpretation that spending in this category has limited flexibility. Mandatory commitments, such as staff payrolls and multiyear urban maintenance contracts, restrict officials' discretion to manipulate the budget in the short term.

In summary, the four models for H2 support the hypothesis for one category (Public Safety), show an effect in the opposite direction for another (Health), and yield inconclusive results for two (Education and Urbhabit). The pattern indicates that the moderating effect of reelection is not uniform across pioneering policies. It is concentrated in expenditure categories with greater electoral visibility and flexibility, refining Nordhaus's (1975) original proposition on electoral budget manipulation in the context of Brazilian municipalities.

Although they are not the central focus of the hypotheses, the control variables have mostly significant coefficients and patterns consistent with the theoretical discussion. GDP per capita (Pibper) has different signs across expenditure categories: positive for health and public safety and negative for education and Urbhabit. This suggests that wealthier municipalities prioritize categories with greater electoral visibility in their current expenditure. Population (Pop) is positively associated with health and education spending, reflecting demand for universal services in larger municipalities, and negatively associated with Urbhabit (coefficient: −0.1731; p-value: < 0.01), possibly because capital resources account for a larger share of spending in this category in

large municipalities. Party alignment with the president (APP) is significant in three of the four models. Its positive coefficient for public safety (coefficient: 0.0807; p-value: < 0.01) suggests coordination across levels of government in federal programs through shared party affiliation, consistent with Baldissera *et al.* (2019). The municipality-size *dummy* variables are systematically significant, underscoring the role of structural differences among Brazilian municipalities in shaping budgetary patterns (Post & Kuipers, 2022) and supporting the methodological decision to retain them as controls.

The findings relate to the Brazilian literature on political budget cycles in different ways. The inconclusive results for Urban Development and Housing, both for the main effect and for its interaction with reelection, contrast in part with Oliveira *et al.* (2023), who found higher infrastructure spending in Brazilian state capitals. This difference may reflect both the measures used, the share of municipal current expenditure versus absolute infrastructure spending, and the budgetary constraints municipalities faced during the period analyzed. That period was marked by financial, political, economic, and public health crises, which may have reduced investment in urban development and housing in favor of urgent needs (Paula & Pires, 2017). The effects observed for Health, Education, and Public Safety, in turn, reinforce the view that the composition of municipal public spending responds to electoral incentives, although the response differs across expenditure categories. This is consistent with earlier studies documenting the pressure that reelection incentives place on budgetary decisions (Rogoff, 1990; List & Sturm, 2006; Sakurai, 2009; Klein & Sakurai, 2015; Bartoluzzio & Anjos, 2020).

5 CONCLUSION

The study analyzed the moderating effect of reelection on the relationship between environmental spending patterns and pioneering policies (health, education, public safety, and urban development and housing) in Brazilian municipalities from 2007 to 2021.

The results for H1, which predicted a negative effect of environmental spending on pioneering policies, were heterogeneous. The hypothesis was supported only in the Education model, which showed a significant negative effect. The health model showed a significant positive effect in the opposite direction, suggesting budgetary complementarity, while the results for Public Safety and Urban Development and Housing were inconclusive. H2, which predicted a negative moderating effect of reelection on this relationship, was supported only in the Public Safety model. The health model showed a significant effect in the opposite direction, while the results for Education and Urban Development and Housing were inconclusive. The partial support for both hypotheses shows that budgetary competition between environmental spending and pioneering policies, and its electoral moderation, vary across expenditure categories.

The results refine political cycle theory (Nordhaus, 1975) by showing that the electoral effect on budget composition differs across expenditure categories. It is concentrated in public safety spending, which has high electoral visibility. This effect is not observed for spending on education or urban development and housing and operates in the opposite direction for health spending. The findings suggest that environmental spending should not be treated as competing uniformly with pioneering policies, given the different patterns observed for health spending (complementarity) and public safety spending (electoral substitution). As a contribution to the literature, the study proposes that the relationship between environmental spending and pioneering policies be understood in terms of each expenditure category's electoral visibility and constraints on resource allocation.

For practice, the findings suggest adopting mechanisms to reduce the environmental budget's exposure to opportunistic electoral cycles, particularly given the prioritization of public safety over the environment observed in reelection contexts. In terms of public oversight, this includes proactive disclosure of environmental management expenditure on municipal transparency portals and stronger municipal environmental councils with a role in budget

deliberations. From a fiscal perspective, the study discusses the possibility of earmarking a minimum percentage of current expenditure for environmental management, as occurs in health and education (Constitutional Amendments 29/2000 and 108/2020), and creating municipal environmental funds with dedicated revenue. These mechanisms could limit officials' discretion over the allocation of resources to environmental management during election periods.

The study has several limitations. Ecosystems may span two or more municipalities, making it difficult to segment municipal analyses by biome and potentially posing challenges to the statistical assumptions of the chosen method. In addition, although secondary data from Finbra and Siconfi enabled a broad quantitative analysis of municipal information, the study period included the years affected by COVID-19 (2020–2021), which may have distorted spending patterns. Finally, expenditure on pioneering or secondary policies was considered aggregate, without distinguishing specific types of spending. The analysis therefore encompassed the full range of public policy benefits provided by mayors.

Future research could segment the analyses by biomes or ecosystems shared across Brazilian states and regions, while identifying municipalities that span more than one biome or ecosystem. It could also examine expenditure by purpose, focusing on one pioneering policy area at a time and investigating how its spending composition changes with municipal officials' reelection strategies.

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CONFLICT OF INTERESTS

The authors declare that there is no conflict of interest.

DATA AVAILABILITY

The complete dataset supporting the findings of this study is available from the authors upon reasonable request.

AUTHOR CONTRIBUTIONS

Roles	1st author	2nd author	3rd author	4th author
Conceptualization	♦	♦		
Data Curation		♦		
Formal Analysis	♦	♦	♦	♦
Funding Acquisition				
Investigation	♦	♦	♦	♦
Methodology		♦		
Project Administration	♦	♦	♦	♦
Resources				
Software		♦		
Supervision			♦	♦
Validation	♦	♦	♦	♦
Visualization	♦	♦	♦	♦
Writing – Original Draft Preparation	♦	♦	♦	♦
Writing – Review & Editing	♦	♦	♦	♦

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