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Essays on Local Public Finance and Education in Paraguay

By

SARA MARIA INES MEZA ARRUA
DISSERTATION

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in

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of the

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DAVIS

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Abstract

This dissertation comprises three essays that examine, on the one hand, how local governments respond to additional resources from the central government and, on the other hand, whether an innovative pedagogical methodology improves student outcomes. The three essays focus on the context of Paraguay, where municipal fiscal capacity remains limited and municipal budgets are highly dependent on central government transfers. At the same time, educational challenges persist in this context, making the evaluation of pedagogical innovations particularly relevant.

The first chapter studies the effects of intergovernmental transfers on local public finance outcomes. In Paraguay, municipalities receive transfers that come mainly from the exploitation of two binational hydroelectric dams. These transfers are partially earmarked for investment purposes. To estimate the causal effects of these hydroelectric dam revenues, I leverage a legally predefined allocation formula used to distribute these revenues that combines an equal-share component with a population-based component within a shift-share instrumental variables design. Results show that transfers generate an expansion of local fiscal activity. On the revenue side, higher transfers increase local tax collection, with positive effects on both property taxes and other locally administered taxes. On the expenditure side, municipalities exhibit a strong flypaper-type response, with increases in total expenditures close to or above one-for-one, in accordance with previous studies on public spending responses to additional transfers. While a significant share of the additional resources is allocated to capital expenditure, consistent with partial earmarking rules, municipalities also increase current expenditure.

I then examine the mechanisms driving these results. I find that increases in other taxes are concentrated in fees and charges linked to local service provision, while property tax effort remains unaffected. Regarding expenditures, the expansion is driven by both investment-related categories and current expenditure, particularly in personnel and operational categories. These patterns suggest that municipalities respond to additional resources by scaling up existing fiscal instruments and administrative structures, rather than undertaking structural improvements in tax enforcement or public finance management.

The second chapter builds directly on the findings of Chapter 1 and investigates whether all municipalities respond similarly to additional transfers. Paraguay has experienced sustained eco-

economic growth since the mid-2000s, but this process has been uneven across municipalities, leading to disparities in local economic conditions and institutional capacity. These differences imply that similar increases in transfers may translate into heterogeneous fiscal responses.

To examine this possibility, I first develop a political economy model of local fiscal behavior in which municipalities differ in their effective public goods technology and the political incentives they face. In this model, municipalities operate in a low- or high-spending regime determined by a public spending threshold. Preferences and composition of informed voters then decide the likelihood of crossing the threshold, while the response of local taxation to transfers depends on the marginal productivity of public spending and the returns to scale of public goods. Next, I test the model predictions empirically by implementing two complementary approaches: (i) I estimate interaction models that allow the causal effect of transfers to vary with predetermined municipal characteristics within the same shift-share instrumental variables framework used in Chapter 1, and (ii) I estimate mixed-effects models that recover municipality-specific responses to predicted transfers, allowing for unobserved heterogeneity in fiscal behavior.

Results demonstrate that municipalities with stronger economic bases, greater urbanization, better infrastructure, and more diversified economic structures tend to exhibit amplified fiscal responses, with increases in both local taxes and public spending. In contrast, more rural and less developed municipalities tend to display weaker fiscal responses and patterns consistent with tax crowd-out. The mixed-effects estimates further show that municipalities are distributed across distinct response regimes, including cases of symmetric high or low responses, and asymmetric adjustments across the two fiscal margins, local taxes and public spending. These patterns suggest that the effectiveness of transfers depends critically on local conditions that shape both the productivity of public spending and the incentives for revenue mobilization.

The third chapter, co-authored with Claudio Cappello and José Molinas Vega, analyzes the effects of an arts-based and active learning methodology, called “Pre-Texts,” on students’ socioemotional and academic outcomes. The methodology combines reading, artistic production, collective discussion, and creative interpretation of texts to promote student engagement with learning activities. To evaluate the effects of this methodology, we run a randomized controlled trial to sixth-grade students in public schools in collaboration with the Paraguayan Ministry of Education and Science and the local partner Instituto Desarrollo. Results indicate moderate but suggestive

effects concentrated primarily in reading-related dimensions. On average, the intervention increases reading enjoyment and reading motivation. We also find evidence of positive effects on academic achievement in Spanish, measured as the probability of achieving the highest score, while effects on Mathematics and grade repetition are limited. Regarding heterogeneous effects, reading outcomes tend to exhibit somewhat larger positive effects among boys and students attending morning-shift schools, while effects for other subgroups are generally smaller and not statistically significant. Taken together, findings suggest that the Pre-Texts methodology may operate primarily through mechanisms related to students' engagement with reading and classroom participation rather than through short-run transformations in socioemotional well-being. This interpretation is consistent with the structure of the intervention itself, which places collective reading and participation at the center of classroom activities.

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Chapter 1

Local Government Decisions and Intergovernmental Transfers: Evidence from Dam Revenues in Paraguay

1.1 Introduction

Over the past decades, decentralization reforms have been encouraged in developing countries to boost economic development and improve efficiency, accountability, and responsiveness in public service delivery. These reforms have primarily involved devolving expenditure responsibilities to subnational governments, while reforms on the revenue side remain limited ([Gadenne and Singhal 2014](#); [Martinez-Vazquez, Lago-Peñas, and Sacchi 2017](#)). In theory, fiscal decentralization should better align public services with local preferences, enabling a more efficient allocation of public goods ([Oates 1999](#)). In practice, however, subnational governments in developing countries face persistent challenges in raising own-source revenue and managing expenditures effectively ([Bahl and Bird 2008](#); [Smoke 2015](#)). Previous studies suggest that part of the explanation lies in subnational governments' heavy reliance on external sources of revenue, such as foreign aid and intergovernmental transfers, to fund their budgets, which could distort incentives, create dependency, encourage inefficient spending patterns, and make decentralization reforms on the revenue side harder to implement ([Oates 1999](#); [Gadenne and Singhal 2014](#); [Martinez-Vazquez, Lago-Peñas, and Sacchi 2017](#)). At the same time, external sources can relax binding budget constraints and enable investments that would otherwise

be infeasible, particularly where local tax bases are narrow and administrative capacity is limited (Besley and Persson 2014; Gadenne 2017). Whether external sources crowd out or crowd in local taxation, and how they translate into the composition of spending, therefore, speaks directly to the classic flypaper effect debate and to broader questions about state capacity and local public finance (Hines and Thaler 1995; Gamkhar and Shah 2007; Inman 2008).

In this paper, I study the effects of formula-based intergovernmental transfers on municipal taxation and public spending. I answer this question in the context of Paraguay, a country that began decentralizing only after the return to democracy in 1989 and remains highly centralized by regional standards. There, municipalities are autonomous local governments empowered to collect their own revenues and provide public goods and services within their territories (Poder Legislativo 2010), yet their fiscal capacity is limited, and their budgets depend heavily on transfers from the central government. The most important transfers originate from two binational hydroelectric dams, Itaipu and Yacyretá, and account for about 89% of municipal transfers and more than half of total municipal revenue, on average (Ministerio de Economía y Finanzas 2005-2024). These dam revenues are distributed monthly according to a legally predefined allocation formula that combines an equal-share component with a population-based component and differs across municipalities classified as affected or non-affected based on their geographic proximity to the hydroelectric dams. These transfers are partially earmarked for investment purposes. The institutional setting thus provides a salient, policy-relevant context for evaluating how intergovernmental transfers shape local fiscal behavior. While the analysis in this chapter focuses on average fiscal responses to transfers, these effects may mask important variation across municipalities, an issue I return to in Chapter 2.

To answer the research question, I compile a novel panel dataset combining multiple administrative sources on intergovernmental transfers, detailed municipal revenues and expenditures, municipal workers, and population for Paraguay’s municipalities over the period 2006–2024 for most of them, complemented with data on hydroelectric production and price and exchange rate series needed to recover aggregate dam revenue shocks. This rich panel allows me to study total municipal taxes and spending, the composition of taxation (property versus other local taxes), the composition of expenditure (current versus capital, and more disaggregated budget categories), and a proxy for property tax effort, defined as the ratio of collected to potential taxes.

Estimating causal effects is challenging because dam revenues allocated to municipalities are not purely mechanical outcomes of the legally predefined formula. Over time, new municipalities were created, and the list of affected municipalities expanded, in some cases in ways that appear inconsistent with geographic proximity to the dams. In addition, audit reports indicate that the central government did not always apply the formula correctly, particularly in the early 2000s, creating scope for political connections and administrative discretion ([Contraloría General de la República 2005-2024](#)). I address these concerns in two steps. First, I estimate panel models with municipality and department-year fixed effects to control for time-invariant municipal characteristics and common departmental shocks. Second, as my main strategy, I implement a shift-share instrumental variables design that exploits two sources of variation embedded in the legal allocation formula: (i) quasi-random annual shocks to aggregate dam revenues driven primarily by annual variation in hydroelectric production and dam-level pricing formulas (the “shift”), and (ii) predetermined municipal exposure measured by baseline population shares within the affected and non-affected groups (the “share”). To mitigate endogenous changes in exposure induced by municipal creation and reclassification, I fix the classification and the number of municipalities at their 2005 levels, restrict the baseline analysis to municipalities that existed in 2005 and did not change status over 2006–2024.

The results show that dam revenues generate a sizable expansion in local fiscal activity. On the revenue side, higher transfers increase local tax collection. A one percentage point (p.p.) increase in dam revenues as a share of the previous year’s total revenues raises total taxes (also measured as a share of lagged total revenues) by about 0.088–0.092 percentage points, with positive effects on both property taxes (0.030–0.034 p.p.) and other taxes (0.053–0.055 p.p.). These effects are precisely estimated and show no systematic differences between affected and non-affected municipalities. On the expenditure side, municipalities exhibit a strong flypaper-type response. They increase total expenditure by roughly one-for-one or more: for each additional Paraguayan Guaraní (PYG) of dam revenues, total expenditure increases by about 0.998–1.275 PYG. The spending response is split between current expenditure (0.440–0.574 per PYG) and capital expenditure (0.547–0.699 per PYG), consistent with partial earmarking toward investment but also indicating significant increases in current expenditure categories.

I then investigate the mechanisms by which municipalities raise taxes and expand spending.

First, despite higher property tax collections, I find no significant increase in property tax effort, suggesting that the tax response may reflect changes in assessed fiscal values or compliance among existing taxpayers rather than improvements in enforcement or administrative capacity. Second, using post-2015 tax detail, the increase in other taxes is concentrated in locally administered fees and charges closely tied to municipal services and regulation, especially vehicle licenses, business permits, and pavement contributions, indicating that municipalities expand revenue instruments that are easier to collect and more directly connected to visible service provision. Third, the increase in current spending is mainly driven by personnel services, consumption goods, and current transfers. Within personnel services, hired (temporary) personnel and basic remunerations (permanent staff salary) account for most of the expansion, in accordance with municipalities relying heavily on short-term hiring for day-to-day operations. On the capital side, the greatest increases occur in construction and in office and computer equipment, illustrating the investment orientation of earmarked transfers. Finally, I provide suggestive evidence that post-2015 staffing rises with dam revenues, although the estimates are imprecise. To summarize, these patterns reveal a fiscal expansion that increases revenues and spending without strengthening underlying tax administration capacity.

This paper contributes to several strands of the fiscal federalism and public finance literature. First, it contributes to the large empirical literature on the flypaper effect by providing new evidence from a setting where intergovernmental transfers are driven by quasi-random variation in natural resource revenues. A central question in this literature is whether transfers stimulate local public spending more than equivalent increases in local income ([Hines and Thaler 1995](#); [Inman 2008](#)). While much of the existing evidence focuses on developed countries, this paper provides new evidence from a developing country context with weaker institutions and evolving intergovernmental systems, where responses to transfers may differ systematically.

Second, an emerging strand of this literature focuses on the impact on local taxes. For example, [Ferraz, Foremny, and Santini 2025](#) find greater increases in tax revenues after a negative than a positive shock in transfers. I complement this literature by providing causal evidence on how exogenous increases in transfers affect both total and disaggregated tax revenues, offering a broad view of how municipalities adjust their own-source revenues. By jointly examining spending and revenue outcomes, I offer a more comprehensive account of municipal fiscal behavior.

Third, the paper contributes to a growing literature examining how local governments adjust across multiple fiscal margins in response to transfers, including taxation and expenditure composition. Recent work highlights that the response to intergovernmental transfers is not limited to aggregate spending and taxation, but also involves reallocations across spending categories and changes in local revenue mobilization (Helm and Stuhler 2024; Ferraz, Foremny, and Santini 2025). By jointly analyzing tax revenues, tax effort, and disaggregated expenditure categories, this paper sheds light on the composition of fiscal adjustment and provides new evidence on the mechanisms underlying local fiscal responses.

Additionally, this paper relates to the natural resource curse literature that documents negative impacts of natural resource revenues on economic growth and development. Previous studies have examined the effect on public spending (Caselli and Michaels 2013; Katovich 2022; Martínez 2022) and public goods, including education and health (Monteiro and Ferraz 2010; Katovich 2022; Martínez 2022), infrastructure and household income (Caselli and Michaels 2013). Nevertheless, the focus has been on revenues from non-renewable natural resources such as oil, gas, or mining (Monteiro and Ferraz 2010; Caselli and Michaels 2013; Katovich 2022; Martínez 2022). Studies of the effects of revenues from renewable natural resources, such as water, are scarce and are usually concentrated in developed countries with strong institutions (Borge, Parmer, and Torvik 2015; Andersen and Sørensen 2022). I then contribute to this literature by providing evidence on how hydroelectric dam-based transfers affect local fiscal behavior in developing countries, which might not be affected by the resource curse even in contexts of low state capacity.

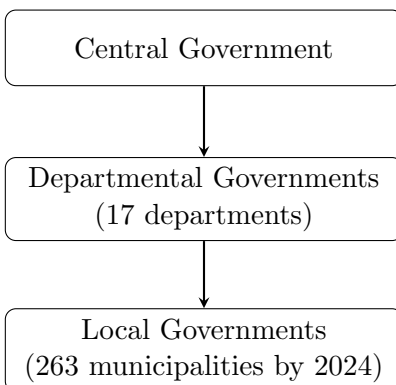
The rest of the paper is organized as follows. Section 1.2 describes Paraguay’s decentralization process, municipal responsibilities, and the legal framework governing hydroelectric dam-based transfers and local taxation. Section 1.3 introduces the data sources used for the analysis. Section 1.4 presents the empirical strategy. Results are shown in section 1.5. Section 1.6 examines mechanisms behind the tax and spending responses. Section 1.7 concludes.

1.2 Institutional Context

For a long time, Paraguay was considered one of the most centralized countries in Latin America. Decentralization began only after the return to democracy in 1989, following 35 years of dictator-

ship, and proceeded at a slower pace than in other countries in the region (Nickson 1997; Nickson 2017). The current National Constitution of 1992 declares Paraguay a unitary and decentralized country, organized into three levels of government: central, departmental, and municipal. The territory is divided into 17 departments plus the capital, Asunción, which is considered a municipality independent of any department (Poder Legislativo 1992). Each department is subdivided into municipalities, the primary units of local government. Figure 1.1 illustrates the governmental administrative structure.

Figure 1.1: Division of Administrative Units in Paraguay



Municipalities are autonomous local governments headed by a mayor and a city council (Poder Legislativo 1992; Poder Legislativo 2010). Yet, mayors were appointed by the President until the first municipal elections in 1991 (Nickson 2016). Since then, local elections have been held roughly every five years. Mayors may be reelected for a second term, consecutive or not, while council members face no term limits (Poder Legislativo 1996; Poder Legislativo 2001).¹

By 2024, Paraguay had 263 municipalities. Nevertheless, the number of municipalities has not been fixed. Between 2005 and 2024, 36 new municipalities were created, raising the total from 227 to 263, a 16% increase. The 1987 Law of Municipalities (Law No. 1294/1987) required a minimum of 5,000 inhabitants for new municipalities, later raised to 10,000 in the 2010 reform (Law No. 3966/2010). Both laws, however, allowed exceptions under special circumstances for better administration, which were invoked in several cases (Poder Legislativo 1987; Poder Legislativo 2010).

According to the Law of Municipalities, municipalities in Paraguay can provide a variety of

¹Some elections take place outside the regular calendar. These are exceptions due to, for example, the creation of a new municipality or the death, resignation, or dismissal of a mayor.

public goods and services to their local communities, including land planning, cleaning, public lighting, sewage, waste management, public transportation, traffic control, education infrastructure, promotion of micro- and small-sized enterprises, and cultural preservation ([Poder Legislativo 1987](#); [Poder Legislativo 2010](#)). In practice, however, their scope remains limited. With few exceptions, responsibility for most public goods and services continues to lie with the central government ([Nickson 2016](#)). Municipal activity is concentrated in areas such as street pavement, garbage collection, cemeteries, municipal markets, bus terminals, public transportation, parks, theaters, food and animal slaughterhouse regulation and control, traffic police, and social assistance ([Gaete 2012](#)).

Municipal revenue is classified into three categories: current, capital, and funding. Current revenue includes taxes, non-tax revenue, sales of public goods and services, current transfers and donations, property rents, operating revenue, and other current revenue. They account for about 45% of total municipal revenue, on average, between 2005 and 2024. Capital revenue consists of asset sales, capital transfers and donations, financial investment, and other capital revenue. They account for around 43% of total municipal revenue, on average. Finally, funding revenue comprises internal and external debt, loan recovery, and opening cash balance, accounting for the remaining 12% of total municipal revenue ([Ministerio de Economía y Finanzas 2005-2024](#)).

The main source of revenue for municipalities is transfers, primarily from the central government. Together, current and capital transfers account for roughly 60% of total municipal revenue. Within these transfer categories, hydroelectric dam revenues are by far the largest component—averaging 53% of total municipal revenue and 89% of all transfers between 2005 and 2024 ([Ministerio de Economía y Finanzas 2005-2024](#)). These originate from two binational hydroelectric dams, meaning that all operational, technical, and financial decisions are made by mutual agreement between the two countries involved. Itaipu is a hydroelectric dam jointly managed by the governments of Brazil and Paraguay, while Yacyreta is managed by the governments of Argentina and Paraguay. On the Paraguayan side, the central government receives funds from the two hydroelectric dams and then transfers them monthly to subnational governments. This money is divided into two categories: (i) revenues, which include Itaipu royalties, Itaipu compensations for transferring energy from Paraguay to Brazil until 2011, and Yacyreta compensations; and (ii) the National Fund for Public Investment and Development (FONACIDE, Fondo Nacional de Inversión Pública

y Desarrollo), created in 2012, which includes Itaipu compensations for energy transfers to Brazil thereafter.

All municipalities receive both types of transfers under a legally predefined allocation formula and classification. Although Itaipu began operations in 1984 and Yacyreta in 1994, municipalities have received the first category only since 2000 and the second category since 2012 ([Poder Legislativo 1998](#); [Poder Legislativo 2012](#)).² Previously, both revenue categories were included in the central government budget only.

Municipalities are classified into one of two groups, “affected” or “non-affected,” based on proximity to the dams. The original idea was to compensate municipalities closer to the dams more than the rest for the negative impacts they may have suffered due to the dam construction, though the classification has often deviated from geographic criteria. Between 2005 and 2024, the number of affected municipalities rose from 48 to 76 (a 58% increase), with some additions far from the dams (Figure 1.2,³ Table 1.1), some corresponding to new municipalities and others to non-affected municipalities reclassified as affected. Laws of Royalties 1309/1998, 3984/2010, and modifications state that affected municipalities receive 15% of revenues, while non-affected municipalities receive 25%. For FONACIDE, Law 4758/2012 and modifications set shares at 7.5% and 12.5%, respectively.⁴ Within each group of municipalities and transfer category, the allocation formula specifies that half of the revenue is distributed equally among municipalities and the other half according to population size ([Poder Legislativo 1998](#); [Poder Legislativo 2010](#)).

Table 1.1: Number of Municipalities in Paraguay by Year, 2005-2024

Municipalities	Year												
	2005-06	2007	2008	2009-10	2011	2012	2013	2014-15	2016	2017-18	2019-2021	2022	2023-24
Total	227	231	232	237	238	244	246	249	250	254	255	262	263
Affected	48	48	52	53	56	57	73	73	73	76	76	76	76
Non-Affected	179	183	180	184	182	187	173	176	177	178	179	186	187

Notes: The table shows the total number of municipalities, affected and non-affected in the country per year during the period 2005–2024. Due to continuous changes in these numbers throughout a given year, the table considers the number of municipalities at the end of each year.

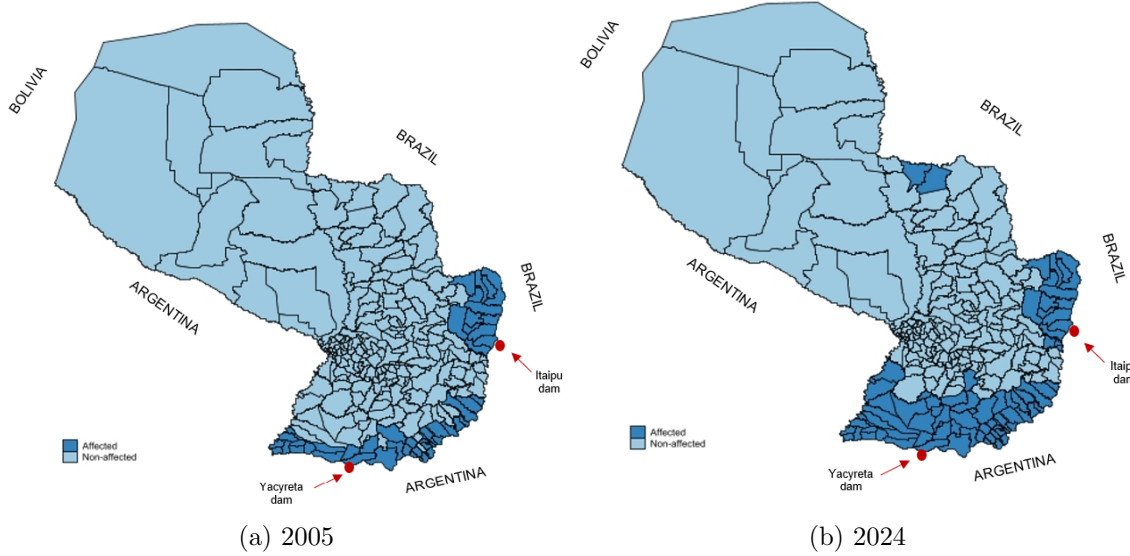
Both transfer categories are partially earmarked. For revenues, 80% must be used for capital

²See Appendix Table A1.1 for details on hydroelectric dam characteristics and revenue types.

³Due to data limitations, the maps in this figure use the existing municipal border limits from 2013 to 2015. The distribution of colors for affected and non-affected municipalities is not altered because the addition of municipalities to the affected group was made among existing municipalities.

⁴Since 2024, FONACIDE has been replaced by the National School Meal Fund (FONAE, Fondo Nacional de Alimentación Escolar), though municipal shares remain unchanged ([Poder Legislativo 2024](#)).

Figure 1.2: Classification of Municipalities By Affected Status, 2005, 2024



spending, 10% for sustainable development initiatives (such as agricultural and industrial production, environmental management, etc.), and 10% for current spending related to capital spending. Municipalities must submit four-monthly financial reports to the General Comptroller of the Republic (CGR, Contraloría General de la República) ([Poder Legislativo 1998](#); [Poder Legislativo 2010](#); [Poder Legislativo 2013](#)). For FONACIDE, around 50% is reserved for school infrastructure, 30% for school meals, and the remainder for public investment and development projects, with semiannual reporting requirements to CGR ([Presidencia de la República 2012](#); [Poder Legislativo 2012](#); [Poder Legislativo 2016](#)).⁵

Taxes are the second-largest municipal revenue source, averaging 20% of total municipal revenue during 2005–2024. Property tax is the largest component, representing, on average, 42% of total municipal taxes ([Ministerio de Economía y Finanzas 2005-2024](#)).

Post-dictatorship reforms decentralized property tax collection to municipalities, which retain 70% of collected property taxes (85% in Asunción), the rest is shared between departmental governments and low-income municipalities, defined by the Ministry of Economy and Finance (MEF, Ministerio de Economía y Finanzas).⁶ Property tax rates are set by the central government. The

⁵Under the recently created Fund FONAE, municipalities must spend at least 70% for school infrastructure and submit four-monthly financial reports to CGR ([Poder Legislativo 2024](#)).

⁶The National Constitution of 1992 ceded the responsibility for collecting property taxes from the central government to municipalities ([Paciello 2007](#)).

general rate is 1%, with the exception of rural, agricultural properties less than 5 hectares, which are taxed at a rate of 0.5% (Poder Legislativo 1991; Poder Legislativo 2010; Poder Legislativo 2015). Property valuations and corresponding property taxes are determined annually by the National Cadastre Service (SNC, Servicio Nacional de Catastro),⁷ which relies on municipal property maps—often outdated—potentially leading to erroneous estimations as some urban properties are labeled as rural and vice versa (The World Bank 2007).⁸ Since 2015, 60% of collected property taxes must be used for capital spending and 40% for current spending (Poder Legislativo 2015). Other tax revenue includes payments for real estate transfers, construction, animal property, advertising, public transportation, gambling, shows, raffles, fines, patents, fees, etc. Municipalities have discretion over patent and fee rates, subject to approval by the city council and mayor. They can spend these other taxes on the services they generate, covering operating costs.

1.3 Data

I compile a novel dataset by combining multiple administrative data sources to estimate the effects of dam revenues on local public finance outcomes. I construct a municipal-level panel dataset comprising data on intergovernmental transfers, fiscal outcomes, municipal workers, and population for 263 municipalities, as well as hydroelectric dam variables, for the sample period 2006–2024. Below, I provide a detailed description of the different data sources.

Dam Revenues. Dam revenue data come from the MEF. This data source differentiates between the two categories of dam revenues discussed in the previous section: revenues and FONACIDE. For the analyses, I define dam revenues as the summation of both categories. Data are available at the municipality-year level from 2006 to 2024 and expressed in millions of 2005 Paraguayan Guaranies (PYG).

Public Finance. Data on local public finance outcomes come from annual financial self-reports submitted by municipalities to the MEF.⁹ These self-reports contain disaggregated information on

⁷The SNC receives 1% of the 70% of property taxes that remain in municipal budgets for its services (Poder Legislativo 2015).

⁸Market values are typically several times higher than fiscal values, used as the tax base. Collection is concentrated in urban areas, since rural collection costs often exceed potential revenue, and penalties for non-payment are weak. These factors result in a property tax collection that remains well below its potential. (The World Bank 2007).

⁹While municipalities are legally required to submit their financial reports in accordance with the Annual Law of the General Budget of the Nation (PGN, Presupuesto General de la Nación), compliance varies by year.

revenue and spending. Both revenue and spending are classified into three main categories: current, capital, and funding. Each main category is further divided into subcategories. Expenditure outcomes include personnel services, non-personnel services, consumption and capital goods, public debt services, current and capital transfers, physical investment, and other current and capital expenditures. Furthermore, I can see these expenditure outcomes in more disaggregated categories. I use financial reports from 2006 to 2024. For the analyses, I consider only the current and capital expenditure categories, as the funding expenditure category was rarely used by municipalities.

While subcategories of revenue and expenditure are available for the entire period, I can disaggregate them even more since 2015, when the MEF began publishing reports with this additional level of detail. In particular, since 2015, I can see the types of taxes collected by municipalities. Before 2015, only aggregate tax amounts were available. Therefore, to construct a consistent property tax and other tax series for 2006–2024, I complement these reports with property tax statements that municipalities submit annually to the MEF. The outcome of other taxes is then defined as the difference between total taxes and property taxes.

In Section 1.2, I explain that the SNC produces annual estimates of fiscal property valuations and corresponding property taxes. These estimates usually differ from the amounts collected for various reasons. The SNC estimates are based solely on the tax due in a given year, regardless of whether taxes for previous years have been paid. In contrast, property taxes collected in a given year include the tax due that year as well as taxes due in previous years. I refer to SNC estimates as potential property taxes and use them to construct a proxy for a tax effort variable. This variable is defined as the ratio of collected to potential property taxes and is used to examine tax efficiency as a possible mechanism driving tax responses. I obtained SNC estimates for the years 2020 and 2022. Using annual percentage changes in the fiscal valuations of properties set by the SNC, I am able to reconstruct the potential property tax series for the period 2006–2024.

All revenue and expenditure outcomes are expressed in millions of 2005 PYG.

Municipal Workers. I obtain the number of employees by municipality from the MEF for the period 2015–2024. I use this data to examine bureaucracy size as a possible mechanism that may drive the main results.

Hydroelectric Dams. I compile data on the components that determine total dam revenues. I use data on the annual hydroelectric production from the Itaipu and Yacyreta dams. This data

is expressed in gigawatts per hour (Gwh). Furthermore, I use data on the industrial goods and consumer price indices, the world export unit value, the export unit value of industrial countries, the US export unit value and the US producer index from the International Financial Statistics of the International Monetary Fund (IMF). In order to convert total amounts of dam revenues into the local currency, I obtain exchange rate data from the Central Bank of Paraguay (BCP, Banco Central del Paraguay). All variables are annual for the period 2006–2024. These variables help me construct a shift-share instrumental variable (IV) to estimate causal effects. More methodological details can be found in Section 1.4.

Population. I use municipal population data from the National Institute of Statistics (INE, Instituto Nacional de Estadística) for the period 2005–2024 to construct the shift-share IV and express expenditure outcomes in per capita terms.

Table 1.2 details the descriptive statistics for the main variables used in the analysis. All monetary values are expressed in millions of 2005 PYG using the BCP Consumer Price Index (CPI). The average municipality has 27,000 inhabitants and 140 municipal workers. From 2006 to 2024, the average total revenue was 6,600 million 2005 PYG, with dam revenues (1,850 million 2005 PYG), property taxes (1,000 million 2005 PYG), and other taxes (1,400 million 2005 PYG) as the key components. During the same period, municipalities spent, on average, 5,500 million 2005 PYG, with the largest share allocated to current expenditures (an average of 3,500 million 2005 PYG, representing 64% of total expenditures). Among current expenditures, personnel services accounted for about 59% (an average of 2,000 million 2005 PYG). This category comprises different types of pay that permanent and temporary workers receive. Interestingly, 50% was allocated to pay temporary workers within the Hired Personnel category (an average of 1,000 million 2005 PYG). In the case of capital expenditures, which account for about 33% of total expenditure, municipalities allocated the largest share to physical investment activities (an average of 1,400 million 2005 PYG).¹⁰

¹⁰ Average shares may vary from values presented above due to different numbers of observations per revenue or expenditure category explained by missing self-reported municipal financial reports.

Table 1.2: Summary Statistics of Main Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
<i>Hydroelectric Dams</i>					
Itaipu Hydroelectric Production (in Gwh)	4,885	86,751.81	10,610.19	65,996.00	102,335.00
Yacyreta Hydroelectric Production (in Gwh)	4,885	17,874.72	2,724.24	13,031.05	21,628.00
<i>Public Finance</i>					
1. Total Revenue	3,691	6,607.76	24,792.49	0.00	591,060.40
1.1 Dam Revenues	4,688	1,847.38	1,956.31	0.00	27,725.98
1.2 Total Taxes	4,173	2,279.22	14,268.54	0.00	395,945.90
1.2.1 Property Taxes	4,592	973.26	6,357.46	0.00	141,097.00
1.2.2 Other Taxes	4,173	1,353.69	8,561.37	0.00	258,692.20
1.2.2.1 <i>Baldío</i> , Vacant Land	2,176	39.58	133.18	0.00	1,764.88
1.2.2.2 Vehicle License	2,200	224.59	531.57	0.00	6,231.31
1.2.2.3 Construction or Building	2,210	106.69	731.35	0.00	21,914.34
1.2.2.4 Subdivision Land	2,127	22.90	98.67	0.00	2,923.95
1.2.2.5 Real Estate Transfer	2,193	44.94	191.35	0.00	5,307.40
1.2.2.6 Gambling	1,660	15.79	87.68	0.00	1,529.23
1.2.2.7 Patent on Profession, Trade & Industry	2,219	510.07	2,029.69	0.00	50,749.01
1.2.2.8 Advertising	2,209	16.61	73.20	0.00	1,565.47
1.2.2.9 Raffle & Lotteries	1,347	2.77	36.27	0.00	1,016.21
1.2.2.10 Public Transportation	1,512	9.50	41.39	0.00	685.18
1.2.2.11 Trademark Registration & Document Legalization	2,094	1.57	6.61	0.00	82.52
1.2.2.12 Stamped Paper & Municipal Stamps	2,218	16.96	67.67	0.00	2,405.03
1.2.2.13 Animal Slaughtherhouse	2,113	11.33	48.01	0.00	746.34
1.2.2.14 Fines	2,179	55.77	292.48	0.00	7,693.69
1.2.2.15 Surcharges	1,100	21.37	62.68	0.00	874.31
1.2.2.16 Contribution for Pavement Conservation	1,819	140.57	1,536.09	0.00	38,431.65
1.2.2.17 Others	1,770	96.58	493.08	0.00	11,149.55
2. Total Expenditure	3,691	5,455.71	19,346.02	28.29	413,721.50
2.1 Current Expenditure	3,691	3,467.58	15,332.68	24.89	328,730.6
2.1.1 Personnel Services	3,690	2,036.15	11,434.19	4.98	254,918.90
2.1.1.1 Basic Remunerations	3,688	779.31	3,870.86	0.00	81,813.71
2.1.1.2 Temporary Remunerations	1,876	21.43	147.11	0.00	3,342.69
2.1.1.3 Complementary Remunerations	3,666	175.12	1,928.47	0.00	44,638.01
2.1.1.4 Hired Personnel	3,684	1,027.84	5,325.08	0.00	119,656.90
2.1.1.5 Other Personnel Expenditure	1,926	87.63	579.47	0.00	12,246.95
2.1.2 Non-Personnel Services	3,690	403.32	1,623.64	0.89	34,408.63
2.1.3 Consumption Goods	3,690	379.01	1,063.33	0.00	19,934.60
2.1.3.1 Food Products	2,682	32.09	144.58	0.00	3,049.27
2.1.3.2 Textiles & Clothing	3,270	9.54	60.07	0.00	1,716.79
2.1.3.3 Paper, Cardboard & Printed Products	3,663	19.35	50.04	0.00	1,033.12
2.1.3.4 Office Goods	3,685	45.86	115.92	0.00	2,213.95
2.1.3.5 Chemical & Medicinal Products	2,784	8.63	35.89	0.00	932.57
2.1.3.6 Fuel & Lubricants	3,683	201.41	455.85	0.00	9,020.36
2.1.3.7 Other Consumption Goods	3,595	76.66	338.63	0.00	8,655.16
2.1.4 Public Debt Service	432	236.30	918.62	0.00	9,184.67
2.1.5 Current Transfers	3,688	486.30	1,102.82	0.00	16,514.46
2.1.5.1 Transfers to Public Sector	586	68.63	277.86	0.00	2,949.79
2.1.5.2 Other Transfers to Public/Private Sector	3,553	186.92	611.34	0.00	10,457.58
2.1.5.3 Transfers to Private Sector	3,672	296.22	539.68	0.00	7,921.26
2.1.6 Other Current Expenditures	3,309	143.36	696.67	0.00	16,904.39
2.2 Capital Expenditure	3,691	1,797.36	3,370.58	0.00	88,150.39
2.2.1 Capital Goods	1,147	76.62	216.51	0.00	3,127.60
2.2.2 Physical Investment	3,689	1,413.99	2,999.76	0.00	88,083.43
2.2.2.1 Real State	1,367	44.64	140.76	0.00	2,507.36
2.2.2.2 Construction	3,683	1,129.53	2,685.65	0.00	85,375.42
2.2.2.3 Machinery, Equipment & Tools	3,476	151.36	493.41	0.00	12,971.22
2.2.2.4 Office & Computer Equipment	3,584	39.83	83.15	0.00	1,896.85
2.2.2.5 Intangible Assets	1,138	17.75	32.68	0.00	349.83
2.2.2.6 Investment Studies & Projects	2,818	44.33	103.70	0.00	3,562.76
2.2.2.7 Other Investment Expenditures	2,431	73.57	123.75	0.00	2,277.13
<i>Municipal Workers</i>					
Number of Employees	2,184	140.16	282.17	11	3,741
<i>Demographics</i>					
Population	4,929	27,240.09	51,156.41	727.00	531,831.00

Notes: All variables include data on 263 municipalities for the period 2006–2024, except for other tax categories and the number of employees (2015–2024). Hydroelectric productions of the Itaipu and Yacyreta dams are annual and do not vary by municipality. All monetary values are expressed in millions of 2005 Paraguayan Guaranies (PYG). Observations differ due to missing municipal financial reports.

1.4 Empirical Strategy

In this paper, I estimate the causal impact of dam revenues on local public finance outcomes in Paraguay. In section 1.4.1, I begin the analysis by leveraging municipal-year level panel data to estimate the effects, while controlling for municipality and department-year fixed effects. By adding these fixed effects, I control for time-invariant municipal characteristics and common shocks that could affect municipalities within a department in the same way in a given year.

Ordinary Least Squares (OLS) estimations with municipality and department-year fixed effects could still be biased due to omitted variable bias. For instance, the creation of new municipalities and the addition of municipalities to the affected list could reflect political lobbying, allowing municipalities with better connections to the central government to access larger portions of dam revenues. In addition, there is evidence showing that the MEF did not apply the predefined formula to distribute the dam revenues to municipalities correctly. According to the CGR, the state regulatory body, the incorrect application of the formula resulted in municipalities receiving more or less than they should have, especially in the first years ([Contraloría General de la República 2005-2024](#)). This situation reinforces the possibility of political connections, making OLS models inappropriate.

I address these concerns by exploiting the fact that the distribution of these transfers depends on two sources of variation: annual hydroelectric production and municipal exposure, which is determined by municipal population size according to a predefined formula. I use these two sources to construct a shift-share IV in a Two-Stage Least Squares (2SLS) design in section 1.4.2.

1.4.1 Panel Fixed Effects Estimation

I begin the analysis by exploiting a municipal-year panel to estimate the effects of dam revenues on local public finance outcomes. The specification includes both municipality and department-year fixed effects. Municipality fixed effects absorb all time-invariant local characteristics that may influence outcomes, such as geographic conditions, baseline institutional capacity, or long-standing political structures. Department-year fixed effects, in turn, capture common shocks that affect all municipalities within the same department in a given year, such as regional weather patterns, political events, or economic cycles, thereby isolating within-department variation across municipalities.

Together, these fixed effects control for persistent local differences and contemporaneous shocks at the departmental level.

The panel fixed effects specification is then defined as follows

$$Y_{idt} = \beta R_{idt} + \delta_i + \mu_{dt} + \varepsilon_{idt} \quad (1.1)$$

where Y_{idt} is an outcome of interest in municipality i of department d in year t and R_{idt} represents the actual distribution of dam revenues to municipality i of department d in year t . Outcomes of interest include tax revenues and public expenditure. Equation 1.1 also includes δ_i and μ_{dt} to control for municipality and department-year fixed effects, respectively. The error term is given by ε_{idt} . Standard errors are clustered two-way by municipality and department-year. For reasons explained below, I also consider an alternative specification that adds an interaction term of the regressor and a dummy variable that equals one if the municipality is affected based on the 2005 classification, $R_{idt} \times \text{Affected}$. This interaction term accounts for differences across affected and non-affected municipalities.

As highlighted in Section 1.2, all municipalities in the country receive dam revenues, and the amount depends on their population size and whether they are classified as affected or non-affected. Yet, the classification of affected and non-affected municipalities, as well as the number of municipalities, changes over the period, reflecting possible political connections. To address these concerns, I maintain the classification and number of municipalities in effect as of 2005, one year before the start of the period of analysis 2006–2024. With these considerations in mind, my sample is initially restricted to 227 municipalities. Some of them changed status from non-affected to affected, while I keep the classification fixed. Therefore, I further restrict my sample to those municipalities that did not change status during 2006–2024. I also discard Asunción, the country’s capital, as the size of this municipality is much larger than that of the rest of the municipalities in terms of population and annual budget. As a result, my sample for the main analyses consists of 200 municipalities that were either always affected or non-affected throughout the period. Of this total, 48 municipalities are affected and 152 are non-affected.

Formally, to interpret β in equation 1.1 as the causal effect of distributed dam revenues on local public finance outcomes, the strict exogeneity condition must hold. Yet, it is likely that

unobserved, time-varying factors are simultaneously correlated with both fiscal outcomes and dam revenues, violating this assumption. In such cases, $E[\varepsilon_{idt}|R_{idt}, \delta_i, \mu_{dt}] \neq 0$, and equation 1.1 yields biased estimates. These concerns motivate the use of an instrumental variables approach. The next subsection describes the construction and identification of the shift-share instrument.

1.4.2 Identification Strategy: Two-Stage Least Squares Estimation

As noted in Section 1.2, the distribution of dam revenues to municipalities is based on a pre-defined formula that indicates that half is distributed equally and the other half is distributed based on the municipal population size. This allocation creates two sources of variation: total annual dam revenues—driven mainly by annual hydroelectric production—and municipal exposure—determined by municipal population size. I leverage these two sources of variation to construct a shift-share IV and estimate the effects using a 2SLS design.

In the following subsections, I explain the construction of the shift-share IV, the first-stage and discuss its validity. Next, I present the reduced-form and second-stage specifications.

1.4.2.1 Shift-Share Instrumental Variable

The construction of the shift-share IV involves several steps. First, I obtain technical formulae from the Itaipu and Yacyreta dams to calculate the amounts they transfer to the government of Paraguay under various categories for the exploitation of the Parana River (both dams are located along the same river).

Second, I extract the fractions of the total dam revenues that go to municipalities. As described in Section 1.2, municipalities receive two categories of transfers: revenues and FONACIDE. According to the Laws of Royalties 1309/1998, 3984/2010 and modifications, 15% of revenues go to affected municipalities and 25% to non-affected municipalities. Law 4758/2012 and modifications state that affected municipalities receive 7.5% and non-affected municipalities receive 12.5% of FONACIDE revenue.¹¹

Third, I employ the formula determined by law to recover the amount of transfers per municipality. The formula specifies that half of the transfers are allocated equally among municipalities

¹¹More details on steps one and two of the construction of the shift-share IV can be found in Appendix B1.

and the other half is based on the municipal population size.¹² The formula is applied separately to affected and non-affected municipalities (Poder Legislativo 1998; Poder Legislativo 2010). Thus, the structure of the formula allows me to construct a shift-share IV type, where the share part is represented by the different municipal exposure to the dam revenues measured by the municipal population size and the shift part is captured by the total annual amount of transfers for municipalities, primarily driven by changes in the hydroelectric production of the dams. Following Borusyak, Hull, and Jaravel 2022; Borusyak, Hull, and Jaravel 2025, I then redefine the formula as

$$\begin{aligned}
R_{idt}^P &= \sum_{a=\{\text{Revenues, FONACIDE}\}} \left[\underbrace{\left(\frac{0.5}{N_{2005}^g} + 0.5 \cdot S_{id,2005}^g \right)}_{\text{Share}} \cdot \underbrace{\omega_{at}^g}_{\text{Shift}} \right], \quad g \in \{\text{Affected, Non-Affected}\} \\
&= \left(\frac{0.5}{N_{2005}^g} + 0.5 \cdot S_{id,2005}^g \right) \cdot \omega_{\text{Revenues},t}^g + \left(\frac{0.5}{N_{2005}^g} + 0.5 \cdot S_{id,2005}^g \right) \cdot \omega_{\text{FONACIDE},t}^g
\end{aligned} \tag{1.2}$$

where R_{idt}^P is the shift-share IV, predicted dam revenues, that instruments the endogenous variable R_{idt} , distributed dam revenues. $\omega_{a,t}^g$ represents the dam revenues shocks, where $\omega_{\text{Revenues},t}^g$ is the total amount transferred to municipalities of group g in year t under the first category Revenues and $\omega_{\text{FONACIDE},t}^g$ is the total amount transferred to municipalities of group g in year t under the second category FONACIDE. N_{2005}^g is the number of municipalities in 2005 in group g and $S_{id,2005}^g$ is the population share of municipality i of department d relative to the total population in 2005 in group g . As explained in Section 1.4.1, I restrict my sample to municipalities that existed in 2005 and did not change status from non-affected to affected during 2006–2024 to address endogenous political connections coming from the creation of new municipalities and the reclassification of some municipalities from non-affected to affected. I also exclude Asunción, the country’s capital, because this municipality is much larger than the others in terms of population and annual budget.

1.4.2.2 First-Stage Specification

First stage is then given by

$$R_{idt} = \gamma R_{idt}^P + \delta_i + \mu_{dt} + v_{idt} \tag{1.3}$$

¹²Strictly speaking, the first Law of Royalties, 1309/1998, stated that the other half should have been distributed based on the municipal population density. Nonetheless, the MEF used municipal population shares instead. The MEF argued that there was a lack of information on municipal areas, which was reinforced in a context of frequent creation of new municipalities. The current Law of Royalties, 3984/2010, changed the expression to population (Contraloría General de la República 2005–2024). Results based on an alternative definition of the shift-share IV using municipal population density can be found in Appendix Table A1.12.

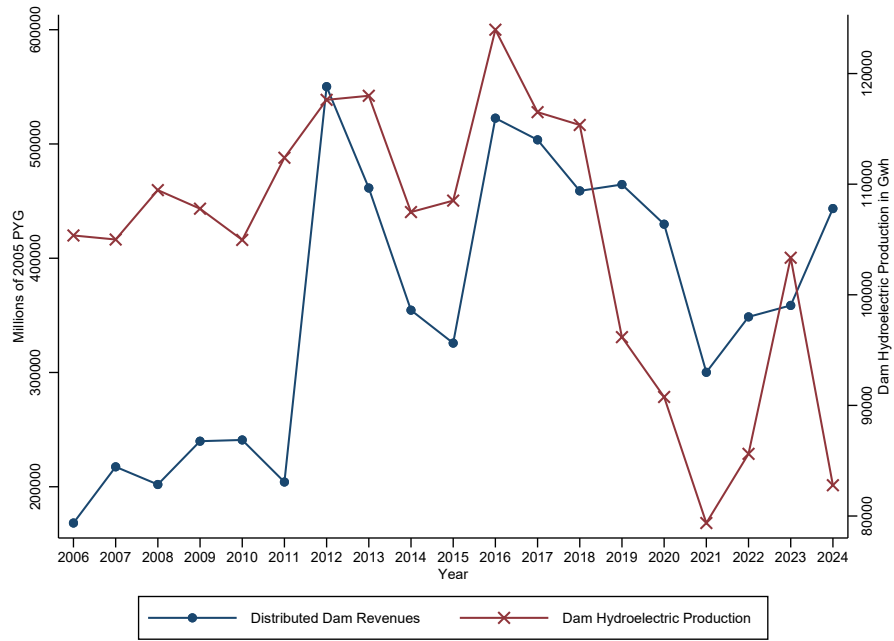
where all variables are defined as before.

Given the assumptions made in the classification of municipalities into affected/non-affected, I also consider an alternative specification that adds an interaction term of the instrument and a dummy variable that equals one if the municipality is affected based on the 2005 classification, $R_{idt}^P \times \text{Affected}$. This interaction term accounts for differences in how the formula translates aggregate shocks into revenues across affected and non-affected municipalities, allowing the first-stage relationship to differ by group.

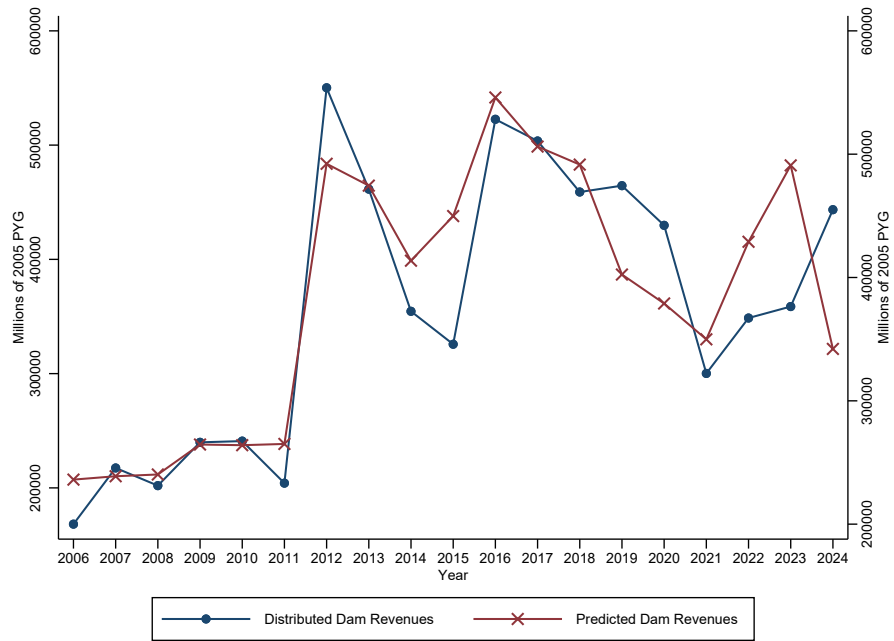
Figure 1.3 shows the annual evolution of distributed dam revenues compared to the annual evolution of the production in Gwh of the two hydroelectric dams (Panel (a)) and the annual evolution of the instrument, predicted dam revenues (Panel (b)) for the sample of 200 municipalities. As expected, distributed dam revenues and hydroelectric production display similar patterns, with both variables experiencing corresponding ups and downs. Likewise, distributed and predicted dam revenues evolve in a similar manner. The instrument overpredicts the actual distribution of dam revenues in some years because it does not account for the creation of new municipalities and the addition of municipalities to the affected group. Moreover, some municipalities did not have positive distributed dam revenues in some years because they either failed to report to the CGR or had their accountability reports rejected. Once they complied with the CGR's requirement, they received pending dam revenues from previous months, together with the corresponding dam revenues for a given month. Nonetheless, Panel (b) underscores the positive relationship between distributed and predicted dam revenues.

A valid IV requires $\gamma \neq 0$ in equation 1.3. That is, predicted dam revenues, R_{idt}^P , must have an effect on distributed dam revenues, R_{idt} . This is the relevance condition. Table 1.3 shows first-stage results that provide evidence in favor of the relevance condition. I find that the coefficient γ is positive and statistically significant at the 1% level. Column (1) shows that an additional million of 2005 PYG of the instrument predicts 0.629 million of 2005 PYG of the actual distribution of dam revenues. The relationship is not one-to-one, reflecting endogenous institutional processes such as municipal creation, status changes, and compliance with the CGR reporting requirements that affected the actual distribution of transfers over time. The instrument abstracts from these processes. When an interaction term of the instrument and a dummy variable that equals one if the municipality is affected based on the 2005 classification is added to the main specification,

Figure 1.3: Distributed Dam Revenues vs Dam Hydroelectric Production & vs Predicted Dam Revenues



(a) Distributed Dam Revenues vs Dam Hydroelectric Production



(b) Distributed Dam Revenues vs Predicted Dam Revenues

Column (2) shows that the instrument predicts 0.424 million of 2005 PYG for affected municipalities and 1.455 million of 2005 PYG for non-affected municipalities. The different magnitudes of the coefficients indicate that, even among always affected municipalities, actual transfers depend on the total number of affected municipalities in a given year, whereas the instrument holds that number fixed at its 2005 level. Nevertheless, results in Table 1.3 demonstrate that predicted dam revenues affect distributed dam revenues. Additionally, Appendix Figure A1.1 provides an illustration of the first stage. It verifies the positive relationship between distributed and predicted dam revenues.

Table 1.3: First-Stage Results

	Distributed Dam Revenues	
	(1)	(2)
Predicted Dam Revenues	0.629*** (0.150)	1.455*** (0.123)
Predicted Dam Revenues $\times$ Affected		-1.031*** (0.129)
Observations	3,791	3,791
R-squared	0.867	0.878
DV Mean	1,792	1,792

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country’s capital. Variables are in millions of 2005 PYG. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

The key identification assumption is that the instrument affects local public finance outcomes only through its effect on distributed dam revenues. This is the exclusion restriction condition. According to Borusyak, Hull, and Jaravel 2022 and Borusyak, Hull, and Jaravel 2025, the unique nature of shift-share IVs composed of two sources of variation allows the researcher to satisfy identification by arguing one of the sources as exogenous. That is, only the shift or the share part needs to be plausibly exogenous to estimate causal effects. Given characteristics of the context explained above, identification relies on quasi-random annual variation in dam revenue shocks (term ω_{at}^g in equation 1.2, the “shift” part) driven by annual variation in hydroelectric production interacting with predetermined municipal exposure (the “share” part), conditional on fixed effects. While municipal population shares may be correlated with local characteristics, hydroelectric production depends on climate and hydrological factors (such as water flow, rainfall, and waterfall height) and

technical and operational factors (including operational efficiency, number of turbines in operation, and dam operational decisions), none of which can be influenced by local governments.

One potential issue with the exogenous shift approach in panel data is that shifts can be serially correlated. Appendix Table A1.2 shows that dam revenue shocks follow a first-order autoregressive process, which provides suggestive evidence of persistence. In these situations, [Borusyak, Hull, and Jaravel 2025](#) propose adding lagged dam revenues and measuring the shares before the sample period. By construction, shares are measured one year before the sample period. Specifications with lagged dam revenues are detailed in Section 1.5.

One potential threat to the validity of the instrument is the potential anticipation of municipalities regarding the amount of transfers they expect to receive from the central government. If they make their revenue and spending decisions based on expected transfers, then shocks are not exogenous, violating the exclusion restriction. I then assess the shock exogeneity assumption underlying the shift-share IV by running lead placebo tests on the main outcomes of interest. Shocks are serially correlated (AR(1)), so lead placebo tests use the residuals of this AR(1) process to construct the lead shift-share IV. This approach isolates unforecastable variation and avoids mechanically attributing contemporaneous effects to predictable future shocks. To account for multi-year spending plans, tests are conducted on the lagged expenditure outcomes. In Section 1.5, the main specifications continue to use total dam revenue shocks to estimate causal effects. Table 1.4 reports the reduced form results. Most outcomes show no evidence of anticipation. For total and other taxes, the lead placebo is negative and statistically significant. However, leave-one-out estimates (Appendix Table A1.3) show that this is not stable over time and is largely driven by the year 2011, suggesting that it is not a systematic anticipation pattern.

1.4.2.3 Reduced-Form and Second-Stage Specifications

The reduced-form specification is given by

$$Y_{idt} = \alpha R_{idt}^P + \delta_i + \mu_{dt} + \nu_{idt} \quad (1.4)$$

where all variables are defined as before.

Table 1.4: Lead Placebo Tests

	<i>Panel A. Tax Revenue Outcomes</i>					
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Predicted Dam Revenues _{t+1}	-0.039*** (0.013)	-0.010 (0.006)	-0.029*** (0.009)	-0.041* (0.024)	-0.002 (0.013)	-0.038*** (0.014)
Predicted Dam Revenues _{t+1} × Affected				0.002 (0.024)	-0.010 (0.012)	0.012 (0.015)
Observations	2,331	2,331	2,331	2,331	2,331	2,331
	<i>Panel B. Public Expenditure Outcomes</i>					
	Total Expenditure _{t-1} (1)	Current Expenditure _{t-1} (2)	Capital Expenditure _{t-1} (3)	Total Expenditure _{t-1} (4)	Current Expenditure _{t-1} (5)	Capital Expenditure _{t-1} (6)
Predicted Dam Revenues _{t+1}	-0.008 (0.065)	-0.019 (0.018)	0.012 (0.051)	-0.067 (0.125)	-0.010 (0.048)	-0.062 (0.101)
Predicted Dam Revenues _{t+1} × Affected				0.063 (0.132)	-0.009 (0.044)	0.079 (0.107)
Observations	2,617	2,617	2,617	2,617	2,617	2,617

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Predicted Dam Revenues are constructed using the residuals of an AR(1) process of the total dam revenue shocks. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

The second-stage is defined as follows

$$Y_{idt} = \beta \hat{R}_{idt} + \delta_i + \mu_{dt} + \varepsilon_{idt} \quad (1.5)$$

where $\hat{R}_{idt}$ is the fitted value of distributed dam revenues for municipality i of department d in year t obtained from running the first-stage specification (equation 1.3). Other variables are defined as before.

For both the reduced-form and second-stage models, I again consider an alternative specification that adds the interaction term $R_{idt}^P \times \text{Affected}$ in the reduced-form specification and as an instrument for $R_{idt} \times \text{Affected}$ in the 2SLS specification.

2SLS estimates measure the average effect for municipalities that comply with the instrument. That is, they measure a Local Average Treatment Effect (LATE) (Imbens and Angrist 1994). More specifically, compliers are municipalities whose distributed dam revenues respond positively to increases in predicted dam revenues resulting from exogenous shocks to hydroelectric production.

1.5 Results

In this section, I present the main results of the chapter. I begin the analysis by estimating the effects of dam revenues on municipal tax revenue. Next, I show the effects on municipal public spending.

1.5.1 Effects on Tax Revenues

Table 1.5 presents the fixed effects (Panel A), reduced form (Panel B) and 2SLS (Panel C) estimates of the effects on local tax revenue. Columns (1)–(3) look at the effects on total, property and other taxes, while columns (4)–(6) present the estimates on the same outcomes, adding the interaction term, $R_{idt}^P \times \text{Affected}$ as an instrument for $R_{idt} \times \text{Affected}$, in the models. Tax outcomes and dam revenues are measured as percentages of the previous year’s total revenues so that coefficients can be interpreted in percentage points (p.p.). Panel A shows that additional dam revenues increase local taxes, with no significant difference between affected and non-affected municipalities. Panels B and C confirm the positive effects on taxes, but with higher coefficients, suggesting that the fixed-effects estimates may be attenuated relative to the 2SLS estimates. This pattern is aligned with the above-mentioned institutional frictions in the allocation of transfers, which may attenuate fixed-effects estimates. More specifically, a one percentage point increase in dam revenues as a share of the previous year’s total revenues increases total taxes by 0.088–0.092 p.p., property taxes by 0.030–0.034 p.p., and other taxes by 0.053–0.055 p.p., with no significant difference by group of municipalities. The effects are significant at the 1% level.

I next assess the robustness of these findings along several dimensions. First, as highlighted in Section 1.4, there is suggestive evidence of persistence of dam revenue shocks as they follow an AR(1) process. Therefore, lags of dam revenues may also impact the outcomes of interest. I evaluate this possibility by including a one-year lag of dam revenues in the specifications, along with its corresponding instrument in the first-stage (Appendix Table A1.4, Panel A). Second, I add the sum of exposure shares of always non-affected municipalities as a control. [Borusyak, Hull, and Jaravel 2022](#) and [Borusyak, Hull, and Jaravel 2025](#) point out that when exposure shares do not add to one, the shift-share IV is no longer a weighted average of the shifts, and observations with higher shares could then systematically obtain higher values of the instrument, leading to

Table 1.5: Effects on Tax Revenues

	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
<i>Panel A. Fixed Effects</i>						
Distributed Dam Revenues	0.066*** (0.018)	0.021*** (0.006)	0.040*** (0.012)	0.066*** (0.022)	0.027*** (0.007)	0.039*** (0.015)
Distributed Dam Revenues $\times$ Affected				-0.001 (0.033)	-0.013 (0.011)	0.003 (0.021)
R^2	0.912	0.881	0.892	0.912	0.881	0.892
<i>Panel B. Reduced Form</i>						
Predicted Dam Revenues	0.091*** (0.010)	0.031*** (0.006)	0.054*** (0.007)	0.099*** (0.018)	0.039*** (0.007)	0.060*** (0.013)
Predicted Dam Revenues $\times$ Affected				-0.018 (0.021)	-0.014 (0.010)	-0.012 (0.015)
R^2	0.914	0.882	0.894	0.915	0.882	0.894
<i>Panel C. 2SLS</i>						
Distributed Dam Revenues [a]	0.092*** (0.019)	0.030*** (0.008)	0.055*** (0.013)	0.088*** (0.026)	0.034*** (0.009)	0.053*** (0.017)
Distributed Dam Revenues $\times$ Affected [b]				0.010 (0.032)	-0.008 (0.014)	0.005 (0.021)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	54.51	65.22	54.51	38.72	35.63	38.72
SW F-stat (1 st Stage) [b]				176.98	83.05	176.98
KP F-stat (1 st Stage)	54.51	65.22	54.51	17.47	17.37	17.47
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed as shares of the previous year's total revenues. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

biased results. The sum of exposure shares for the always non-affected group does not add to one because, by construction, the instrument includes the 2005 municipalities that changed status in practice, whereas the specifications consider only municipalities that did not change status except for Asunción, the capital (Appendix Table A1.5, Panel A). Third, I augment specifications with municipality-specific linear time trends to address possible differential pre-existing trajectories (Appendix Table A1.6, Panel A). Fourth, I consider an alternative sample by adding the 2005 municipalities that changed status (Appendix Table A1.7, Panel A). Results remain qualitatively similar across these alternative specifications.

Model estimations assume a linear relationship between dam revenues and outcomes of interest. Nevertheless, this relationship could be non-linear. Appendix Table A1.8, Panel A, reports the results on tax revenue for specifications that add the square of dam revenues, along with its corresponding instrument in the first stage. The effects on tax outcomes remain positive but higher, whereas the quadratic terms are small in magnitude and sensitive to weak instrument concerns. I also break down the average effects into above and below the median of annual dam revenue or production shocks to examine asymmetric effects. Results in Appendix Tables A1.9 and A1.10, Panel A, demonstrate that the impact of dam revenues on taxes is higher when dam revenue or production shocks are below the median than when they are above it, indicating stronger tax responses in years with smaller amounts of transfers.

Baseline specifications measure the contemporaneous effects of dam revenues. To assess whether the effects persist over time, I estimate cumulative specifications in which both outcomes and dam revenues are cumulated over time and normalized once. Appendix Table A1.11, Panel A, shows that while the short-run estimates indicate that dam revenues increase local tax collection, the cumulative effects on taxes are small and statistically insignificant, suggesting limited persistence in tax responses.

Additionally, I measure two alternative definitions of the instrument, each with a stricter interpretation of the Laws of Royalties. First, the initial Law of Royalties 1309/1998 stated that one half of the dam revenues should have been distributed equally among municipalities and the other half based on the municipal population density. Instead, the MEF used municipal population shares for the second half. I construct then an alternative instrument based on population densities in Appendix Table A1.12. Panel A shows the first-stage results. The effects, while significant, are

essentially zero. In Panel B, the effects on tax outcomes are qualitatively similar to the baseline specifications, though the F-statistic is less than 10, as expected. Second, the same Law specified only two categories of dam revenues to be distributed to municipalities: Itaipu royalties and Yacyreta compensations for flooded territory. Later, the new Law of Royalties 3984/2010 and the Law of FONACIDE 4758/2012 officially incorporated the remaining categories of Itaipu compensations for transferring electricity from Paraguay to Brazil and Yacyreta compensations for transferring electricity from Paraguay to Argentina into the calculation. However, CGR reports concluded that the MEF possibly also transferred the last two categories of compensation before their official incorporation into the calculation. Hence, I re-defined the shift-share IV to account for this stricter composition of dam revenues. Appendix Table [A1.13](#), Panel A, presents the first-stage results. As expected, the coefficients are smaller, reflecting the lower predictability of the actual distribution of dam revenues among municipalities. In Panel B, the effects on tax revenues are similar to those in the baseline specifications, although slightly smaller. In general, these alternative IV definitions indicate that the baseline shift-share IV reasonably well predicts the actual distribution of dam revenues under the assumptions made.

Because financial reports are self-reported by municipalities, the panel is unbalanced and reporting behavior may be selective. To assess potential sample selection bias, I first test whether the probability of reporting is correlated with predicted dam revenues. I find no systematic relationship between reporting and the instrument, suggesting that reporting behavior is not driven by dam revenue shocks (Appendix Table [A1.14](#)). Additionally, I verify that the results are similar when restricting the sample to municipalities with high reporting rates (≥ 0.7), defined as the ratio of years reported to the total years in the sample period. These findings indicate that sample selection is unlikely to drive the main results (Appendix Table [A1.15](#), Panel A).

Overall, findings show that dam revenues lead to higher local tax collection, indicating a crowding-in effect. Therefore, it appears that municipalities view both revenue sources as complements rather than substitutes.

1.5.2 Effects on Public Expenditures

Table [1.6](#) reports the fixed effects (Panel A), reduced form (Panel B) and 2SLS (Panel C) estimates of the effects on local public spending. Columns (1)–(3) look at the effects on total, current and

capital expenditure, while columns (4)–(6) present the estimates on the same outcomes, adding the interaction term, $R_{idt}^P \times \text{Affected}$ as instrument for $R_{idt} \times \text{Affected}$, in the models. Coefficients measure municipalities’ marginal propensity to spend out of dam revenues. Panel A shows that additional dam revenues raise local public spending, but there is no significant difference between affected and non-affected municipalities. As in the case of the effects on tax revenue, Panels B and C verify a higher increase in public expenditure, again suggesting attenuation in the fixed effects estimates relative to the 2SLS results. Here, for each additional PYG of dam revenues, municipalities spend PYG 0.998–1.275 out of dam revenues, significant at the 1% level, implying a spending response close to or greater than one-for-one. This is consistent with a strong flypaper-type response in Paraguayan municipalities. Spending can exceed the transfer increase if, for example, municipalities also raise own-source revenues (as shown above) or reallocate other budget components in response to transfers. Of the increase in total expenditure, PYG 0.440–0.574 is spent in current expenditure and PYG 0.547–0.699 in capital expenditure, significant at the 1% level. These results suggest that municipalities allocate a large share of the additional transfers to capital expenditure, consistent with legal earmarking, although current spending also increases significantly. Even though the difference in effects by affected status is negative, it is not statistically significant across any expenditure category.

Here, I run the same additional models that I detailed when explaining the effects on taxes as robustness checks. When I add a one-year lag of dam revenues in the specifications, Appendix Table A1.4, Panel B, shows that lagged dam revenues also impact public expenditure outcomes, reflecting multi-year spending adjustments. This is especially true for capital expenditure, which includes investment categories. Robustness checks obtain qualitatively similar results when I account for the sum of exposure shares of always non-affected municipalities, municipality-specific linear time trends, and an alternative sample that includes municipalities that changed status (Appendix Tables A1.5–A1.7, Panel B).

Appendix Table A1.8, Panel B, demonstrates that, once quadratic dam revenues are added, the effects on current expenditures increase, while the effects on capital expenditure are no longer significant when there is no interaction term. Regarding asymmetric effects, evidence indicates that when dam revenue or production shocks are below the median, municipalities increase total spending more than when shocks are above their median, driven by an increase in current expen-

Table 1.6: Effects on Public Expenditures

	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
<i>Panel A. Fixed Effects</i>						
Distributed Dam Revenues	0.681*** (0.084)	0.213*** (0.045)	0.455*** (0.056)	0.752*** (0.161)	0.276*** (0.095)	0.476*** (0.099)
Distributed Dam Revenues $\times$ Affected				-0.124 (0.184)	-0.109 (0.105)	-0.036 (0.108)
R^2	0.905	0.879	0.873	0.905	0.879	0.873
<i>Panel B. Reduced Form</i>						
Predicted Dam Revenues	0.643*** (0.160)	0.283*** (0.084)	0.352*** (0.120)	1.376*** (0.278)	0.620** (0.247)	0.755*** (0.110)
Predicted Dam Revenues $\times$ Affected				-0.965*** (0.284)	-0.443* (0.246)	-0.529*** (0.117)
R^2	0.895	0.878	0.860	0.900	0.882	0.863
<i>Panel C. 2SLS</i>						
Distributed Dam Revenues [a]	0.998*** (0.187)	0.440*** (0.129)	0.547*** (0.146)	1.275*** (0.284)	0.574** (0.247)	0.699*** (0.089)
Distributed Dam Revenues $\times$ Affected [b]				-0.443 (0.308)	-0.216 (0.251)	-0.243 (0.171)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1^{st} Stage) [a]	55.01	55.01	55.01	259.60	259.60	259.60
SW F-stat (1^{st} Stage) [b]				263.46	263.46	263.46
KP F-stat (1^{st} Stage)	55.01	55.01	55.01	22.95	22.95	22.95
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

diture, while capital expenditure either remains unchanged or decreases slightly (Appendix Table A1.9-A1.10, Panel B). These findings suggest that in years when municipalities receive transfers below the median, they protect current expenditure, delaying capital investment. In the case of cumulative effects, cumulative spending responds strongly and proportionally to cumulative dam revenues, with coefficients close to one (Appendix Table A1.11, Panel B). This implies that municipalities translate increases in transfers into sustained increases in public expenditure over time. Together, these findings indicate that the positive tax responses observed in the baseline specifications are transitory, whereas expenditure responses reflect persistent adjustments in local fiscal behavior.

With regard to the alternative definitions of the instrument, when I consider municipal population density as exposure shares, the results in Appendix Table A1.13, Panel C, although positive and significant, must be interpreted with caution, as the instrument is weak. Using the stricter composition of dam revenues, Appendix Table A1.13, Panel C, reports similar coefficients to baseline specifications.

Finally, Appendix Table A1.14 shows that there is no significant relationship between the probability of reporting expenditure outcomes and the instrument. In addition, results are similar to the baseline specifications when restricting the sample to high-reporting municipalities (Appendix Table A1.15, Panel B). These findings indicate that reporting behavior is not selective among municipalities for expenditure outcomes either.

In summary, dam revenues generate an expansion of municipal spending. The increase is split between current and capital expenditures, with greater effects on the latter category. Combined with the above tax results, this spending behavior is consistent with a strong spending response to transfers, alongside complementary increases in own-source revenues. These findings point to a fiscal expansion channel in which intergovernmental transfers relax budget constraints without displacing own-source revenue mobilization.

1.6 Mechanisms

Based on the average effects found in Section 1.5, I now examine different mechanisms that may drive the positive impact of dam revenues on tax revenues and public expenditures. I start by ana-

lyzing a measure of tax collection effort, categories of tax revenue, current and capital expenditure and then turn to bureaucracy size.

1.6.1 Tax Collection Effort, Other Taxes on Property, Goods and Services

As highlighted in Section 1.2, property taxes account for the largest share of total taxes. While Table 1.5 reports positive effects on collected property taxes, this increase could reflect changes in the assessed tax base, such as automatic updates to property valuations rather than improvements in municipal enforcement capacity. To distinguish changes in collections from changes in the assessed base, I define property tax effort as the ratio of collected to potential property taxes. Table 1.7 reports 2SLS estimates of the effects of dam revenues on the effort ratio in Columns (5) and (6). The estimated coefficient is close to zero and statistically insignificant, indicating that municipalities do not increase collections relative to their assessed potential.

To make this decomposition transparent, Table 1.7 also reports results for the numerator and denominator separately, estimated on an identical sample used for the effort regression in Columns (1)–(4) and expressed in millions of 2005 PYG. The estimates show that dam revenues increase both collected and potential property taxes. The increase in collections is smaller than the increase in potential, which explains the absence of a detectable effect on the effort ratio. Taken together, these results imply that the expansion in property tax revenues is not driven by improvements in collection efficiency relative to the assessed base. Instead, it is accordance with changes in assessed fiscal values and/or compliance among existing taxpayers that move alongside the tax base.

One possible interpretation of the positive effects on potential property taxes is that increases in transfers coincide with changes in the underlying tax base, such as urban expansion or updates to property valuations. However, the construction of the potential tax series relies primarily on centrally determined adjustments, which limits the extent to which these changes can be interpreted as direct responses to dam revenues. The response of potential property taxes should therefore be interpreted with caution. The constructed measure of potential property taxes relies on updating municipality-specific fiscal values using common inflation adjustments and administrative rules. As a result, part of the variation in potential property taxes reflects the interaction of a common updating process with heterogeneous baseline fiscal values across municipalities, rather than discretionary reassessments induced by transfers. I therefore treat the effort ratio, together with the

joint evidence on collections and potential, as the primary diagnostic for whether municipalities strengthen enforcement capacity in response to transfers. The absence of an effect on effort suggests that higher transfers do not translate into improved tax administration, even though they increase total collections.

Table 1.7: Effects on Property Tax Effort

	Collected Property Taxes Levels		Potential Property Taxes Levels		Property Tax Effort Ratios	
	(1)	(2)	(3)	(4)	(5)	(6)
Distributed Dam Revenues [a]	0.751*** (0.200)	0.531*** (0.098)	1.086*** (0.370)	0.597*** (0.183)	0.003 (0.003)	0.003 (0.004)
Distributed Dam Revenues $\times$ Affected [b]		0.447* (0.270)		0.994** (0.419)		0.002 (0.004)
Observations	3,695	3,695	3,695	3,695	3,695	3,695
SW F-stat (1 st Stage) [a]	17.35	148.04	17.35	148.04	130.87	86.14
SW F-stat (1 st Stage) [b]		111.11		111.11	265.43	
KP F-stat (1 st Stage)	17.35	31.08	17.35	31.08	130.87	42.89
DV mean in 2006	304.9	304.9	514.2	514.2	51.86	51.86

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables in Columns (1)–(4) are expressed in millions of 2005 PYG. Variables in Columns (5)–(6) are expressed as shares of potential property taxes. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Next, I examine what can explain the increase in other taxes. Municipal financial reports have included disaggregated information on tax types since 2015. Therefore, the sample period for this analysis runs from 2015 to 2024. In addition to taxes levied on property values, municipalities also levy taxes on other types of property. Among them, vehicle licenses stand out as the most relevant ones, as reported in Table 1.8. This finding highlights one of the main roles of municipalities, issuing vehicle licenses. Another important service municipalities provide is the authorization for certain economic activities under the name of Patent on Profession, Trade & Industry. Table 1.9 shows that this tax experiences an increase due to additional dam revenues. Finally, municipalities are also responsible for maintaining streets in good condition. According to Table 1.10, additional dam revenues lead to a significant increase in this tax, under the name of Contribution for Pavement Conservation. These findings reveal that municipalities expand fees and taxes tied to local service provision and regulation, rather than strengthening enforcement, as property tax effort remains unchanged.

Table 1.8: Effects on Other Taxes on Property

	<i>Baldío,</i> Vacant Land (1)	Vehicle License (2)	Construction or Building (3)	Subdivision Land (4)	Real Estate Transfer (5)
<i>Panel A. Baseline Specification</i>					
Distributed Dam Revenues	0.002** (0.001)	0.012** (0.005)	0.003** (0.001)	0.002*** (0.001)	0.002 (0.002)
Observations	1,544	1,559	1,551	1,501	1,539
SW F-stat (1 st Stage)	309.09	39.43	39.86	272.40	278.92
KP F-stat (1 st Stage)	309.09	39.43	39.86	272.40	278.92
DV mean in 2015	0.126	2.880	0.653	0.211	0.570
<i>Panel B. Baseline Specification + Interaction Term</i>					
Distributed Dam Revenues [a]	0.002** (0.001)	0.012* (0.007)	0.004* (0.002)	0.002** (0.001)	0.003 (0.004)
Distributed Dam Revenues $\times$ Affected [b]	-0.001 (0.001)	0.001 (0.007)	-0.003 (0.002)	-0.001 (0.001)	-0.002 (0.005)
Observations	1,544	1,559	1,551	1,501	1,539
SW F-stat (1 st Stage) [a]	475.89	75.06	76.69	476.84	482.55
SW F-stat (1 st Stage) [b]	381.22	135.50	135.26	388.77	387.47
KP F-stat (1 st Stage)	235.47	54.30	54.40	236.07	238.42
DV mean in 2015	0.126	2.880	0.653	0.211	0.570

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2015-2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table 1.9: Effects on Taxes on Goods and Services

	Patent on		Raffles &		Public		Trademark Registration		Stamped Paper	
	Gambling	Profession, Trade & Industry	Advertising	Lotteries	Transportation		& Document Legalization		& Municipal Stamps	Animal Slaughterhouse
	(1)	(2)	(3)	(4)	(5)		(6)		(7)	(8)
<i>Panel A. Baseline Specification</i>										
Distributed Dam Revenues	0.000 (0.000)	0.014** (0.006)	0.001*** (0.000)	0.001 (0.001)	0.001*** (0.000)		0.001** (0.000)		0.001 (0.001)	0.001*** (0.000)
Observations	1,176	1,565	1,563	885	1,026		1,465		1,566	1,483
SW F-stat (1 st Stage)	35.40	39.52	39.51	178.82	36.28		43.18		39.91	39.47
KP F-stat (1 st Stage)	35.40	39.52	39.51	178.82	36.28		43.18		39.91	39.47
DV mean in 2015	0.121	5.222	0.149	0.00736	0.175		0.0378		0.269	0.140
<i>Panel B. Baseline Specification + Interaction Term</i>										
Distributed Dam Revenues [a]	0.000 (0.000)	0.013* (0.008)	0.001*** (0.000)	0.003 (0.003)	0.001*** (0.000)		0.001*** (0.000)		0.001 (0.001)	0.002*** (0.001)
Distributed Dam Revenues × Affected [b]	0.000 (0.001)	0.003 (0.008)	-0.001** (0.000)	-0.003 (0.003)	-0.001** (0.000)		-0.001*** (0.000)		0.000 (0.001)	-0.001* (0.001)
Observations	1,176	1,565	1,563	885	1,026		1,465		1,566	1,483
SW F-stat (1 st Stage) [a]	70.34	75.19	75.21	477.57	126.25		76.80		77.20	76.64
SW F-stat (1 st Stage) [b]	84.35	136.20	135.90	550.86	292.34		187.46		137.01	137.00
KP F-stat (1 st Stage)	16.37	54.67	54.44	231.32	100.33		73.57		55.60	55.17
DV mean in 2015	0.121	5.222	0.149	0.00736	0.175		0.0378		0.269	0.140

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2015-2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table 1.10: Effects on Other Taxes

	Fines	Surcharges	Contribution for Pavement Conservation	Others
	(1)	(2)	(3)	(4)
<i>Panel A. Baseline Specification</i>				
Distributed Dam Revenues	0.001 (0.001)	0.004** (0.002)	0.012*** (0.004)	0.004** (0.002)
Observations	1,528	733	1,285	1,235
SW F-stat (1 st Stage)	40.39	132.02	259.57	205.45
KP F-stat (1 st Stage)	40.39	132.02	259.57	205.45
DV mean in 2015	0.441	0.248	1.706	0.788
<i>Panel B. Baseline Specification + Interaction Term</i>				
Distributed Dam Revenues [a]	0.001 (0.001)	0.004* (0.002)	0.020*** (0.007)	0.002 (0.002)
Distributed Dam Revenues $\times$ Affected [b]	0.001 (0.001)	0.001 (0.005)	-0.015* (0.007)	0.003 (0.003)
Observations	1,528	733	1,285	1,235
SW F-stat (1 st Stage) [a]	75.86	414.62	368.03	459.02
SW F-stat (1 st Stage) [b]	130.22	91.99	371.41	376.63
KP F-stat (1 st Stage)	52.62	14.43	182.32	229.55
DV mean in 2015	0.441	0.248	1.706	0.788

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2015-2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

1.6.2 Personnel, Consumption Goods, Transfers and Investment Spending

To investigate the mechanisms behind the positive impact on public spending, I disentangle current and capital expenditures to see what categories drive the budget expansion on the expenditure side. According to Table 1.11, the increase in current expenditures is explained mainly by personnel services, consumption goods and current transfers.

Table 1.11: Effects on Current Expenditures

	Personnel Services (1)	Non-Personnel Services (2)	Consumption Goods (3)	Public Debt Service (4)	Current Transfers (5)	Other Current Expenditure (6)
<i>Panel A. Baseline Specification</i>						
Distributed Dam Revenues	0.123*** (0.043)	0.084* (0.043)	0.062** (0.027)	0.018 (0.058)	0.143*** (0.030)	0.030** (0.015)
Observations	2,969	2,969	2,969	270	2,970	2,674
SW F-stat (1 st Stage)	55.00	55.00	55.00	15.52	55.01	55.74
KP F-stat (1 st Stage)	55.00	55.00	55.00	15.52	55.01	55.74
DV mean in 2006	0.031	0.010	0.011	0.002	0.006	0.003
<i>Panel B. Baseline Specification + Interaction Term</i>						
Distributed Dam Revenues [a]	0.138* (0.070)	0.170 (0.105)	0.071* (0.039)	0.070*** (0.026)	0.163*** (0.034)	0.038 (0.026)
Distributed Dam Revenues × Affected [b]	-0.024 (0.074)	-0.139 (0.109)	-0.015 (0.042)	-0.076 (0.069)	-0.031 (0.043)	-0.013 (0.028)
Observations	2,969	2,969	2,969	270	2,970	2,674
SW F-stat (1 st Stage) [a]	259.50	259.50	259.50	29.43	259.60	242.18
SW F-stat (1 st Stage) [b]	263.39	263.39	263.39	45.26	263.46	261.62
KP F-stat (1 st Stage)	22.95	22.95	22.95	13.73	22.95	33.40
DV mean in 2006	0.031	0.010	0.011	0.002	0.006	0.003

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Personnel services comprise various payments that permanent or temporary public employees receive for their work. Among personnel service categories, hired personnel and basic remunerations stand out as the main drivers of the expansion, as shown in Table 1.12. Hired personnel are considered temporary employees (qualified and unqualified) who do not receive social security benefits, while permanent staff, who receive all the benefits, obtain basic remunerations. These findings suggest that municipalities rely on temporary employees for their daily operations.

In the case of consumption goods, fuel and lubricants lead the increase (Table 1.13). These results suggest that municipalities expand their spending in consumption good categories that may be counted as related to capital spending.

Table 1.12: Effects on Personnel Services

	Basic Remunerations (1)	Temporary Remunerations (2)	Complementary Remunerations (3)	Hired Personnel (4)	Other Personnel Expenditure (5)
<i>Panel A. Baseline Specification</i>					
Distributed Dam Revenues	0.061** (0.027)	0.004 (0.002)	-0.001 (0.004)	0.076*** (0.023)	-0.017 (0.012)
Observations	2,968	1,469	2,950	2,964	1,545
SW F-stat (1 st Stage)	54.63	48.42	59.33	54.86	50.57
KP F-stat (1 st Stage)	54.63	48.42	59.33	54.86	50.57
DV mean in 2006	0.0136	0.0007	0.0013	0.0143	0.0009
<i>Panel B. Baseline Specification + Interaction Term</i>					
Distributed Dam Revenues [a]	0.038 (0.026)	0.003 (0.004)	0.006 (0.007)	0.102** (0.039)	-0.010 (0.008)
Distributed Dam Revenues × Affected [b]	0.037 (0.043)	0.000 (0.004)	-0.012 (0.008)	-0.042 (0.042)	-0.010 (0.013)
Observations	2,968	1,469	2,950	2,964	1,545
SW F-stat (1 st Stage) [a]	259.40	132.53	249.43	258.37	226.45
SW F-stat (1 st Stage) [b]	263.48	141.55	255.24	262.63	213.29
KP F-stat (1 st Stage)	22.77	25.48	23.19	22.95	14.50
DV mean in 2006	0.0136	0.0007	0.0013	0.0143	0.0009

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table 1.13: Effects on Consumption Goods

	Food Products (1)	Textiles & Clothing (2)	Paper, Cardboard & Products (3)	Office Goods (4)	Chemical & Medical (5)	Fuel & Lubricants (6)	Other Goods (7)
<i>Panel A. Baseline Specification</i>							
Distributed Dam Revenues	-0.028** (0.013)	0.000 (0.002)	0.001 (0.001)	0.007 (0.005)	-0.000 (0.002)	0.040** (0.017)	0.017** (0.008)
Observations	2,151	2,640	2,948	2,965	2,237	2,966	2,898
SW F-stat (1 st Stage)	26.65	48.46	60.49	56.66	78.82	54.97	52.80
KP F-stat (1 st Stage)	26.65	48.46	60.49	56.66	78.82	54.97	52.80
DV mean in 2006	0.0003	0.0001	0.0006	0.0009	0.0003	0.0080	0.0007
<i>Panel B. Baseline Specification + Interaction Term</i>							
Distributed Dam Revenues [a]	-0.024* (0.014)	0.001 (0.002)	0.001 (0.001)	0.004 (0.004)	0.001 (0.001)	0.057** (0.025)	0.018** (0.007)
Distributed Dam Revenues × Affected [b]	-0.009 (0.019)	-0.002 (0.002)	-0.001 (0.001)	0.006 (0.008)	-0.003 (0.003)	-0.027 (0.028)	-0.002 (0.012)
Observations	2,151	2,640	2,948	2,965	2,237	2,966	2,898
SW F-stat (1 st Stage) [a]	158.24	210.63	251.57	259.63	180.00	258.33	220.68
SW F-stat (1 st Stage) [b]	134.85	219.89	271.77	264.45	180.24	262.87	235.53
KP F-stat (1 st Stage)	17.27	26.77	33.68	24.15	20.85	22.95	22.17
DV mean in 2006	0.0003	0.0001	0.0006	0.0009	0.0003	0.0080	0.0007

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

As for current transfers, they are contributions to other public institutions or the private sector. Table 1.14 shows that transfers to the private sector and other transfers to public/private sector explain the increase. It appears thus that municipalities raise their provision of scholarships and contributions between them, to foundations, non-governmental organizations, schools, and civil organizations.

Table 1.14: Effects on Current Transfers

	Transfers to Public Sector (1)	Other Transfers to Public/Private Sector (2)	Transfers to Private Sector (3)
<i>Panel A. Baseline Specification</i>			
Distributed Dam Revenues	-0.013 (0.013)	0.022* (0.012)	0.121*** (0.025)
Observations	416	2,867	2,957
SW F-stat (1 st Stage)	58.98	59.83	54.42
KP F-stat (1 st Stage)	58.98	59.83	54.42
DV mean in 2006	0.0010	0.0031	0.0028
<i>Panel B. Baseline Specification + Interaction Term</i>			
Distributed Dam Revenues [a]	-0.028 (0.023)	0.033 (0.022)	0.133*** (0.022)
Distributed Dam Revenues × Affected [b]	0.021 (0.018)	-0.018 (0.018)	-0.019 (0.035)
Observations	416	2,867	2,957
SW F-stat (1 st Stage) [a]	133.77	220.54	258.85
SW F-stat (1 st Stage) [b]	282.84	240.29	261.82
KP F-stat (1 st Stage)	26.53	26.59	22.89
DV mean in 2006	0.0010	0.0031	0.0028

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Regarding capital expenditure, most of the categories are not statistically significant, as shown in Table 1.15. The expansion is explained by additional investments. Among them, infrastructure construction and the purchase of office and computer equipment drive the results (Table 1.16). These findings suggest that municipalities invest in the construction of new buildings or the renovation of existing ones and their corresponding office equipment. Based on the Laws of Royalties and FONACIDE, these investments should be applied mostly to the education sector.

Table 1.15: Effects on Capital Expenditure

	Capital Goods (1)	Physical Investment (2)	Capital Transfers (3)	Other Capital Expenditure (4)
<i>Panel A. Baseline Specification</i>				
Distributed Dam Revenues	0.005 (0.026)	0.524*** (0.146)	0.024 (0.035)	0.015 (0.039)
Observations	839	2,968	2,849	1,594
SW F-stat (1 st Stage)	15.63	54.95	53.63	59.01
KP F-stat (1 st Stage)	15.63	54.95	53.63	59.01
DV mean in 2006	0.0021	0.0483	0.0258	0.0112
<i>Panel B. Baseline Specification + Interaction Term</i>				
Distributed Dam Revenues [a]	0.030 (0.024)	0.657*** (0.084)	0.021 (0.023)	0.030 (0.021)
Distributed Dam Revenues × Affected [b]	-0.029 (0.038)	-0.213 (0.180)	0.005 (0.051)	-0.021 (0.056)
Observations	839	2,968	2,849	1,594
SW F-stat (1 st Stage) [a]	29.63	258.52	251.27	159.52
SW F-stat (1 st Stage) [b]	47.05	262.86	267.63	171.94
KP F-stat (1 st Stage)	17.57	22.95	20.05	25.56
DV mean in 2006	0.0021	0.0483	0.0258	0.0112

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table 1.16: Effects on Physical Investment

	Real Estate (1)	Construction (2)	Machinery, Equipment & Tools (3)	Office & Computer Equipment (4)	Intangible Assets (5)	Investment & Studies Projects (6)	Other Investment Expenditure (7)
<i>Panel A. Baseline Specification</i>							
Distributed Dam Revenues	-0.015 (0.039)	0.432*** (0.147)	0.031 (0.031)	0.031*** (0.008)	0.004 (0.005)	-0.008 (0.014)	0.028 (0.021)
Observations	1,006	2,963	2,795	2,878	829	2,258	1,970
SW F-stat (1 st Stage)	44.26	55.28	60.66	54.81	27.49	55.47	47.48
KP F-stat (1 st Stage)	44.26	55.28	60.66	54.81	27.49	55.47	47.48
DV mean in 2006	0.0016	0.0404	0.0043	0.0013	0.0004	0.0032	0.0023
<i>Panel B. Baseline Specification + Interaction Term</i>							
Distributed Dam Revenues [a]	0.020 (0.020)	0.563*** (0.094)	0.048** (0.021)	0.021*** (0.004)	0.007 (0.008)	-0.008 (0.015)	0.015 (0.012)
Distributed Dam Revenues × Affected [b]	-0.059 (0.067)	-0.208 (0.180)	-0.026 (0.048)	0.015 (0.011)	-0.006 (0.008)	0.000 (0.022)	0.020 (0.029)
Observations	1,006	2,963	2,795	2,878	829	2,258	1,970
SW F-stat (1 st Stage) [a]	76.36	258.69	282.91	224.72	108.71	162.38	87.21
SW F-stat (1 st Stage) [b]	104.19	256.90	285.81	241.92	138.83	160.69	115.16
KP F-stat (1 st Stage)	11.77	22.95	21.25	23.63	90.22	21.77	16.69
DV mean in 2006	0.0016	0.0404	0.0043	0.0013	0.0004	0.0032	0.0023

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

1.6.3 Municipal Employees

Another channel that could help interpret the impact of dam revenues on taxes and public expenditure is the size of bureaucracy. On the one hand, the expansion of current expenditure, particularly personnel services, may translate into hiring more employees. At the same time, more employees may facilitate the execution of capital projects, which may help explain the increase in capital expenditure. On the other hand, more employees may improve tax administration, thereby increasing tax collection. However, as shown earlier, tax collection effort does not increase. As a result, if the size of bureaucracy increases but tax effort does not, hiring new staff does not improve tax administration capacity.

Table 1.17 shows that municipalities expand their staff in response to additional dam revenues, although not significantly, providing suggestive evidence that part of the increase in taxes and spending operates through the expansion of the local public sector. Because tax effort does not change, hiring new staff does not improve tax administration capacity, indicating a weak institutional response. These results must be interpreted as suggestive evidence. Due to data availability, they are based on a shorter sample period (2015–2024) and an unbalanced panel, as data is not available for all municipalities in the sample.

Table 1.17: Effects on Number of Municipal Employees

	Number of Employees	
	(1)	(2)
Distributed Dam Revenues [a]	0.020 (0.023)	0.010 (0.025)
Distributed Dam Revenues $\times$ Affected [b]		0.026 (0.031)
Observations	1,699	1,699
SW F-stat (1 st Stage) [a]	10.76	20.46
SW F-stat (1 st Stage) [b]		10.30
KP F-stat (1 st Stage) [b]	10.76	1.63
DV mean in 2015	0.005	0.005

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed in per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2015–2024. Two-way clustered SE by municipality and department-year are reported in ().

*** p<0.01, ** p<0.05, * p<0.1.

1.7 Conclusion

This paper studies how formula-based intergovernmental transfers affect local fiscal behavior, focusing on municipal taxation and public spending in Paraguay. To estimate causal effects, I exploit quasi-random variation in hydroelectric dam revenues—driven by fluctuations in hydroelectric production and pricing—to construct a shift-share instrumental variable that isolates exogenous changes in transfers. This approach allows me to overcome concerns related to political discretion, municipal reclassification, and administrative irregularities in the distribution of transfers.

The results show that increases in dam revenues lead to an expansion of local fiscal activity. On the revenue side, municipalities respond to higher transfers by increasing tax collection, with positive effects on both property taxes and other locally administered taxes. On the expenditure side, transfers translate into substantial increases in spending, with effects that are close to or above one-for-one. While a significant share of the additional resources is allocated to capital expenditure, municipalities also increase current expenditure in accordance with partial earmarking rules.

Taken together, these findings provide evidence on the flypaper effect. Rather than crowding out local taxation, transfers in this setting crowd in tax revenues, but without improving underlying fiscal capacity. Moreover, the strong spending response confirms that external resources translate disproportionately into public expenditure.

The analysis of mechanisms clarifies how municipalities adjust across fiscal margins. On the revenue side, increases in other taxes are concentrated in fees and charges linked to local service provision, while property tax effort remains unaffected. On the expenditure side, the expansion is driven by both investment-related categories and current expenditure, particularly on personnel and operational categories. These patterns suggest that municipalities respond to additional transfers by scaling up existing fiscal instruments and administrative structures, rather than undertaking structural improvements in tax enforcement or public finance management.

These findings have important policy implications. First, they suggest that formula-based transfers tied to natural resource revenues can effectively expand local fiscal capacity in terms of resources available for spending. However, without complementary reforms aimed at strengthening tax administration and institutional capacity, such transfers may not lead to sustained improvements in revenue mobilization. Second, the coexistence of increased investment and current spending high-

lights the importance of monitoring the composition of expenditure, particularly in contexts where transfers are partially earmarked but enforcement is imperfect. An important avenue for future research is to examine whether these fiscal responses translate into longer-term differences in local development outcomes, public service delivery, and state capacity.

More generally, this paper contributes to the understanding of fiscal decentralization in developing countries by showing that the effects of transfers depend not only on their size but also on the institutional environment in which they operate. In settings with limited administrative capacity, transfers may generate expansion along observable fiscal outcomes without inducing deeper changes in how local governments raise and manage resources. At the same time, the combination of strong spending responses and increases in local taxation without improvements in tax effort may appear counterintuitive in light of the existing literature, which often emphasizes limited local revenue responses. These findings suggest that the average effects documented in this paper may mask important differences in how municipalities adjust across fiscal margins.

Thus, a natural next step is to move beyond average effects and examine whether and how responses to transfers vary across municipalities. The next chapter builds on this insight by developing a framework that allows for heterogeneous fiscal responses and by empirically investigating the extent and determinants of this variation.

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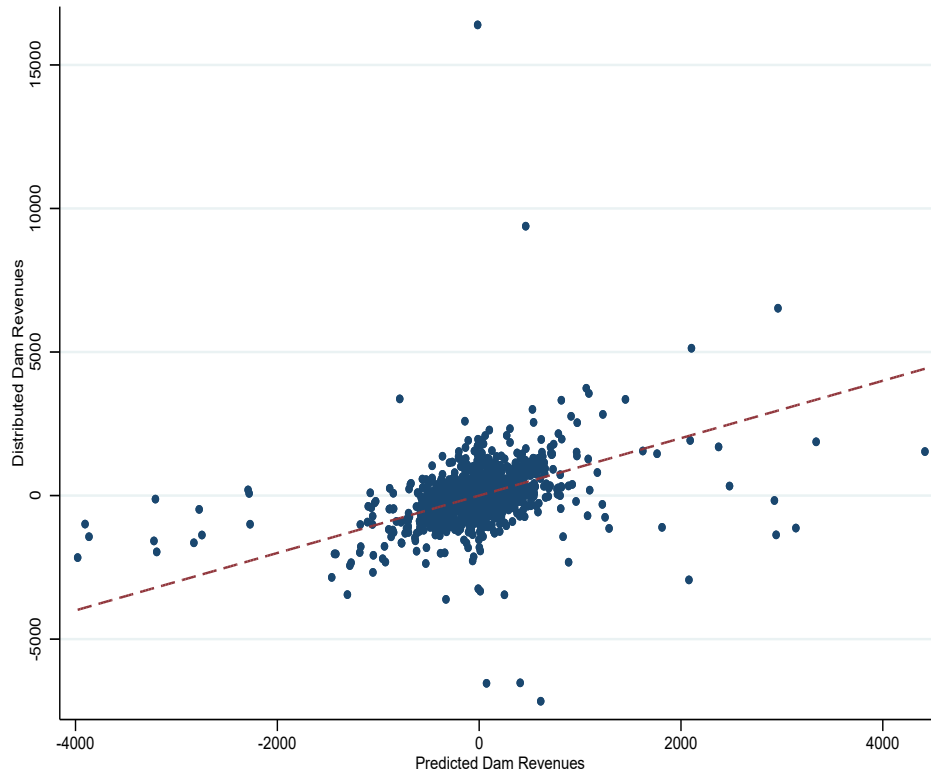
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A1 Appendix: Additional Figures and Tables

Figure A1.1: First-Stage Relationship



Notes: Each point in the scatterplot represents the residual values in a municipality's actual and predicted dam revenues over the period 2006–2024 after controlling for municipality and department-year fixed effects.

Table A1.1: Main Characteristics of the Itaipu and Yacyreta Dams

Characteristic	Itaipu Dam	Yacyreta Dam
Binational Treaty	Signed by Brazil and Paraguay in 1973	Signed by Argentina and Paraguay in 1973
Installed Capacity	14,000 MW	3,200 MW
Beginning of Operations	1984	1994
Beginning of Distribution of Revenues to Central Government	1985	1994
Beginning of Distribution of Revenues to Municipalities	2000	2000
Types of Revenues	Royalties: payments for electricity use in Paraguay and Brazil. Compensation for transferring energy from Paraguay to Brazil: this revenue goes to the FONACIDE Fund since its creation in 2012.	Compensation due to the flooded territory. Compensation for transferring energy from Paraguay to Argentina.
Rates	Royalties: \$650 per gigawatts/hour. Compensation for transferring energy from Paraguay to Brazil: \$300 per gigawatts/hour.	Compensation due to the flooded territory: based on predefined formula. Compensation for transferring energy from Paraguay to Argentina: \$2,998 per gigawatts/hour.

Sources: Binational Entity Itaipu (EBI), Binational Entity Yacyreta (EBY), [Poder Legislativo 2009](#), [Presidencia de la República 2012](#).

Table A1.2: AR(1) Results of Dam Revenue Shocks

	Dam Revenue Shocks	
	One Lag	Two Lags
	(1)	(2)
Dam Revenue Shocks _{t-1}	0.716*** (0.175)	0.785* (0.460)
Dam Revenue Shocks _{t-2}		-0.097 (0.519)
Observations	19	19

Notes: Sample consists of annual dam revenue shocks constructed using the dam technical formulae. Variables are in 2005 PYG. Sample period 2006–2024. *** p<0.01, p<0.05, * p<0.1.

Table A1.3: Leave-One-Out Results on Total and Other Taxes

	Total Taxes (1)	Other Taxes (2)	Total Taxes (3)	Other Taxes (4)
2006	-0.037*** (0.013)	-0.025*** (0.009)	-0.043* (0.024)	-0.035** (0.014)
2007	-0.041*** (0.013)	-0.029*** (0.009)	-0.047* (0.024)	-0.039*** (0.014)
2008	-0.040*** (0.013)	-0.029*** (0.009)	-0.044* (0.024)	-0.040*** (0.013)
2009	-0.042*** (0.013)	-0.031*** (0.009)	-0.044* (0.024)	-0.040*** (0.013)
2010	-0.039*** (0.014)	-0.028*** (0.010)	-0.041 (0.026)	-0.039** (0.015)
2011	-0.024 (0.023)	-0.022 (0.016)	0.032 (0.047)	-0.009 (0.030)
2012	-0.040*** (0.013)	-0.029*** (0.009)	-0.042* (0.024)	-0.039*** (0.014)
2013	-0.040*** (0.013)	-0.029*** (0.009)	-0.040 (0.024)	-0.037*** (0.014)
2014	-0.040*** (0.013)	-0.030*** (0.009)	-0.043* (0.023)	-0.040*** (0.013)
2015	-0.038*** (0.014)	-0.028*** (0.009)	-0.041* (0.024)	-0.038*** (0.014)
2016	-0.041*** (0.013)	-0.030*** (0.009)	-0.043* (0.025)	-0.040*** (0.014)
2017	-0.039*** (0.013)	-0.029*** (0.009)	-0.040* (0.024)	-0.038*** (0.014)
2018	-0.036*** (0.013)	-0.027*** (0.009)	-0.038 (0.024)	-0.037*** (0.014)
2019	-0.037*** (0.013)	-0.028*** (0.009)	-0.038 (0.023)	-0.037*** (0.013)
2020	-0.036*** (0.013)	-0.027*** (0.009)	-0.037 (0.023)	-0.037*** (0.013)
2021	-0.042*** (0.013)	-0.030*** (0.009)	-0.043* (0.024)	-0.040*** (0.014)
2022	-0.037*** (0.013)	-0.025*** (0.009)	-0.037 (0.023)	-0.035** (0.014)
2023	-0.047*** (0.014)	-0.038*** (0.009)	-0.054** (0.023)	-0.051*** (0.012)
2024	-0.039*** (0.013)	-0.029*** (0.009)	-0.041* (0.024)	-0.038*** (0.014)

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Variables are expressed as shares of the previous year's total revenues. Columns (2) and (4) include the interaction term Predicted Dam Revenues_{t+1} × Affected. Each row contains the leave-one-out estimates excluding the specified year. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.4: Effects on Tax Revenues and Public Expenditures: Lagged Dam Revenues

<i>Panel A. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.084*** (0.019)	0.034*** (0.008)	0.051*** (0.013)	0.095*** (0.025)	0.038*** (0.011)	0.058*** (0.018)
Distributed Dam Revenues _{t-1} [b]	-0.004 (0.008)	-0.005* (0.003)	0.001 (0.006)	-0.018 (0.013)	-0.009** (0.004)	-0.009 (0.011)
Distributed Dam Revenues $\times$ Affected [c]				-0.030 (0.034)	-0.011 (0.014)	-0.018 (0.025)
Distributed Dam Revenues _{t-1} $\times$ Affected [d]				0.027* (0.015)	0.008 (0.005)	0.019* (0.011)
Observations	2,146	2,301	2,146	2,146	2,301	2,146
SW F-stat (1 st Stage) [a]	484.26	470.99	484.26	1,135.20	1,163.37	1,135.20
SW F-stat (1 st Stage) [b]	160.89	156.69	160.89	108.35	110.77	108.35
SW F-stat (1 st Stage) [c]				532.58	484.81	532.58
SW F-stat (1 st Stage) [d]				215.78	208.12	215.78
KP F-stat (1 st Stage)	244.00	229.73	244.00	34.60	30.60	34.60
DV mean in 2007	23.37	10.18	13.19	23.37	10.18	13.19
<i>Panel B. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	0.699*** (0.158)	0.271*** (0.095)	0.387*** (0.140)	0.945*** (0.300)	0.369 (0.251)	0.562*** (0.098)
Distributed Dam Revenues _{t-1} [b]	0.402** (0.155)	0.255*** (0.094)	0.185* (0.106)	0.481*** (0.148)	0.272*** (0.076)	0.221** (0.100)
Distributed Dam Revenues $\times$ Affected [c]				-0.335 (0.311)	-0.134 (0.235)	-0.238 (0.177)
Distributed Dam Revenues _{t-1} $\times$ Affected [d]				-0.196 (0.252)	-0.055 (0.134)	-0.107 (0.158)
Observations	2,840	2,840	2,840	2,840	2,840	2,840
SW F-stat (1 st Stage) [a]	48.88	48.88	48.88	64.09	64.09	64.09
SW F-stat (1 st Stage) [b]	55.18	55.18	55.18	31.89	31.89	31.89
SW F-stat (1 st Stage) [c]				122.20	122.20	122.20
SW F-stat (1 st Stage) [d]				69.59	69.59	69.59
KP F-stat (1 st Stage)	11.04	11.04	11.04	6.58	6.58	6.58
DV mean in 2007	0.124	0.064	0.058	0.124	0.064	0.058

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.5: Effects on Tax Revenues and Public Expenditures: Incomplete Shares of Always Non-Affected Municipalities as Control

	<i>Panel A. Tax Revenue Outcomes</i>		
	Total Taxes	Property Taxes	Other Taxes
	(1)	(2)	(3)
Distributed Dam Revenues	0.084*** (0.026)	0.031*** (0.009)	0.053*** (0.018)
Observations	2,085	2,223	2,085
SW F-stat (1 st Stage)	29.32	30.20	29.32
KP F-stat (1 st Stage)	29.32	30.20	29.32
DV mean in 2006	19.46	8.957	10.50
	<i>Panel B. Public Expenditure Outcomes</i>		
	Total Expenditure	Current Expenditure	Capital Expenditure
	(1)	(2)	(3)
Distributed Dam Revenues	1.364*** (0.283)	0.608** (0.248)	0.753*** (0.080)
Observations	2,263	2,263	2,263
SW F-stat (1 st Stage)	203.58	203.58	203.58
KP F-stat (1 st Stage)	203.58	203.58	203.58
DV mean in 2006	0.099	0.049	0.050

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.6: Effects on Tax Revenues and Public Expenditures: Municipal Linear Trend

	<i>Panel A. Tax Revenue Outcomes</i>					
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.096*** (0.017)	0.031*** (0.008)	0.056*** (0.011)	0.093*** (0.023)	0.039*** (0.008)	0.054*** (0.016)
Distributed Dam Revenues $\times$ Affected [b]				0.006 (0.029)	-0.013 (0.013)	0.005 (0.020)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	60.49	67.88	60.49	38.12	35.75	38.12
SW F-stat (1 st Stage) [b]				151.26	80.10	151.26
KP F-stat (1 st Stage)	60.49	67.88	60.49	18.10	17.87	18.10
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23
	<i>Panel B. Public Expenditure Outcomes</i>					
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	0.809*** (0.132)	0.187*** (0.071)	0.604*** (0.118)	0.980*** (0.212)	0.260 (0.172)	0.712*** (0.112)
Distributed Dam Revenues $\times$ Affected [b]				-0.257 (0.244)	-0.110 (0.185)	-0.163 (0.140)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	54.16	54.16	54.16	187.03	187.03	187.03
SW F-stat (1 st Stage) [b]				179.22	179.22	179.22
KP F-stat (1 st Stage)	54.16	54.16	54.16	16.86	16.86	16.86
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.7: Effects on Tax Revenues and Public Expenditures: Sample That Includes 2005 Municipalities That Changed Status

	<i>Panel A. Tax Revenue Outcomes</i>					
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.106*** (0.021)	0.033*** (0.010)	0.063*** (0.014)	0.112*** (0.030)	0.044*** (0.011)	0.066*** (0.020)
Distributed Dam Revenues $\times$ Affected [b]				-0.014 (0.026)	-0.020 (0.013)	-0.008 (0.017)
Observations	3,078	3,298	3,078	3,078	3,298	3,078
SW F-stat (1 st Stage) [a]	60.63	69.18	60.63	42.47	43.51	42.47
SW F-stat (1 st Stage) [b]				117.41	90.96	117.41
KP F-stat (1 st Stage)	60.63	69.18	60.63	20.60	21.42	20.60
DV mean in 2006	18.94	8.385	10.56	18.94	8.385	10.56
	<i>Panel B. Public Expenditure Outcomes</i>					
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	1.020*** (0.202)	0.437*** (0.150)	0.569*** (0.145)	1.206*** (0.213)	0.504*** (0.180)	0.705*** (0.090)
Distributed Dam Revenues $\times$ Affected [b]				-0.173 (0.133)	-0.062 (0.099)	-0.126 (0.106)
Observations	3,354	3,354	3,354	3,354	3,354	3,354
SW F-stat (1 st Stage) [a]	26.67	26.67	26.67	70.34	70.34	70.34
SW F-stat (1 st Stage) [b]				109.40	109.40	109.40
KP F-stat (1 st Stage)	26.67	26.67	26.67	31.43	31.43	31.43
DV mean in 2006	0.134	0.060	0.073	0.134	0.060	0.073

Notes: Sample consists of 226 municipalities, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.8: Effects on Tax Revenues and Public Expenditures: Quadratic Dam Revenues

	<i>Panel A. Tax Revenue Outcomes</i>					
	Total Taxes	Property Taxes	Other Taxes	Total Taxes	Property Taxes	Other Taxes
	(1)	(2)	(3)	(4)	(5)	(6)
Distributed Dam Revenues [a]	0.227*** (0.065)	0.142* (0.085)	0.134*** (0.049)	0.280*** (0.079)	0.120*** (0.027)	0.162*** (0.062)
Distributed Dam Revenues ² [b]	-0.000** (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.001*** (0.000)	-0.000*** (0.000)	-0.000* (0.000)
Distributed Dam Revenues $\times$ Affected [c]				-0.068 (0.086)	-0.060** (0.026)	-0.008 (0.068)
Distributed Dam Revenues ² $\times$ Affected [d]				0.000 (0.000)	0.000*** (0.000)	-0.000 (0.000)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	6.21	0.58	6.21	10.26	3.67	10.26
SW F-stat (1 st Stage) [b]	4.94	0.58	4.94	7.41	3.27	7.41
SW F-stat (1 st Stage) [c]				119.75	42.30	119.75
SW F-stat (1 st Stage) [d]				122.32	18.01	122.32
KP F-stat (1 st Stage)	1.13	0.29	1.13	0.65	0.68	0.65
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23

	<i>Panel B. Public Expenditure Outcomes</i>					
	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Distributed Dam Revenues [a]	1.569*** (0.505)	1.054*** (0.301)	0.583 (0.359)	2.309*** (0.564)	1.408*** (0.443)	0.916*** (0.271)
Distributed Dam Revenues ² [b]	-0.502 (0.332)	-0.540** (0.233)	-0.032 (0.207)	-1.593*** (0.599)	-1.264*** (0.445)	-0.345 (0.329)
Distributed Dam Revenues $\times$ Affected [c]				-0.917 (0.558)	-0.398 (0.410)	-0.449 (0.317)
Distributed Dam Revenues ² $\times$ Affected [d]				1.270** (0.561)	0.849** (0.424)	0.360 (0.283)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	38.39	38.39	38.39	53.33	53.33	53.33
SW F-stat (1 st Stage) [b]	26.77	26.77	26.77	58.75	58.75	58.75
SW F-stat (1 st Stage) [c]				166.58	166.58	166.58
SW F-stat (1 st Stage) [d]				143.46	143.46	143.46
KP F-stat (1 st Stage)	18.78	18.78	18.78	24.38	24.38	24.38
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.9: Asymmetric Effects on Tax Revenues and Public Expenditures: Dam Revenue Shocks

<i>Panel A. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues ₊ [a]	0.064*** (0.016)	0.022*** (0.006)	0.034*** (0.010)	0.062*** (0.019)	0.027*** (0.007)	0.033*** (0.012)
Distributed Dam Revenues ₋ [b]	0.127*** (0.013)	0.044*** (0.007)	0.081*** (0.009)	0.140*** (0.022)	0.047*** (0.011)	0.094*** (0.015)
Distributed Dam Revenues ₊ × Affected [c]				0.007 (0.026)	-0.010 (0.010)	0.005 (0.016)
Distributed Dam Revenues ₋ × Affected [d]				-0.025 (0.026)	-0.005 (0.014)	-0.023 (0.018)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	283.64	297.07	283.64	189.84	184.72	189.84
SW F-stat (1 st Stage) [b]	58.78	111.07	58.78	65.73	67.05	65.73
SW F-stat (1 st Stage) [c]				314.37	331.65	314.37
SW F-stat (1 st Stage) [d]				207.52	127.98	207.52
KP F-stat (1 st Stage)	30.76	64.98	30.76	41.94	23.84	41.94
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23
<i>Panel B. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues ₊ [a]	1.053*** (0.300)	0.644*** (0.202)	0.397** (0.196)	1.503*** (0.388)	0.813** (0.320)	0.689*** (0.097)
Distributed Dam Revenues ₋ [b]	1.096*** (0.407)	0.808*** (0.273)	0.277 (0.252)	1.767*** (0.555)	1.105** (0.446)	0.663*** (0.131)
Distributed Dam Revenues ₊ × Affected [c]				-0.746* (0.428)	-0.286 (0.308)	-0.477* (0.270)
Distributed Dam Revenues ₋ × Affected [d]				-1.061* (0.620)	-0.469 (0.427)	-0.610 (0.373)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	23.90	23.90	23.90	72.64	72.64	72.64
SW F-stat (1 st Stage) [b]	25.81	25.81	25.81	98.26	98.26	98.26
SW F-stat (1 st Stage) [c]				79.45	79.45	79.45
SW F-stat (1 st Stage) [d]				118.73	118.73	118.73
KP F-stat (1 st Stage)	11.94	11.94	11.94	5.30	5.30	5.30
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Dam revenue shocks are positive if they are at or above the median. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.10: Asymmetric Effects on Tax Revenues and Public Expenditures: Dam Production Shocks

<i>Panel A. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues ₊ [a]	0.054*** (0.019)	0.015** (0.006)	0.032*** (0.012)	0.055** (0.023)	0.024** (0.009)	0.029* (0.016)
Distributed Dam Revenues ₋ [b]	0.109*** (0.024)	0.042*** (0.009)	0.065*** (0.016)	0.105*** (0.038)	0.039*** (0.012)	0.067** (0.026)
Distributed Dam Revenues ₊ × Affected [c]				-0.002 (0.032)	-0.014 (0.010)	0.008 (0.022)
Distributed Dam Revenues ₋ × Affected [d]				0.007 (0.040)	0.008 (0.014)	-0.004 (0.027)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	37.56	43.51	37.56	29.53	31.64	29.53
SW F-stat (1 st Stage) [b]	627.22	196.08	627.22	1,755.47	2,159.01	1,755.47
SW F-stat (1 st Stage) [c]				237.40	305.54	237.40
SW F-stat (1 st Stage) [d]				448.89	1,358.19	448.89
KP F-stat (1 st Stage)	24.11	19.97	24.11	5.37	5.44	5.37
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23
<i>Panel B. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues ₊ [a]	1.071*** (0.202)	0.542*** (0.141)	0.526*** (0.155)	1.336*** (0.283)	0.643*** (0.243)	0.694*** (0.084)
Distributed Dam Revenues ₋ [b]	1.208*** (0.242)	0.735*** (0.180)	0.486*** (0.183)	1.523*** (0.314)	0.858*** (0.274)	0.676*** (0.084)
Distributed Dam Revenues ₊ × Affected [c]				-0.437 (0.314)	-0.167 (0.255)	-0.278 (0.192)
Distributed Dam Revenues ₋ × Affected [d]				-0.529 (0.353)	-0.207 (0.298)	-0.321 (0.240)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	52.00	52.00	52.00	144.46	144.46	144.46
SW F-stat (1 st Stage) [b]	50.72	50.72	50.72	209.57	209.57	209.57
SW F-stat (1 st Stage) [c]				173.17	173.17	173.17
SW F-stat (1 st Stage) [d]				235.83	235.83	235.83
KP F-stat (1 st Stage)	25.13	25.13	25.13	14.60	14.60	14.60
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Dam production shocks are positive if they are at or above the median. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.11: Cumulative Effects on Tax Revenues and Public Expenditures

<i>Panel A. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.010 (0.028)	0.011 (0.014)	-0.003 (0.016)	0.015 (0.039)	0.015 (0.020)	-0.002 (0.023)
Distributed Dam Revenues $\times$ Affected [b]				-0.011 (0.043)	-0.009 (0.020)	-0.002 (0.027)
Observations	2,959	2,959	2,959	2,959	2,959	2,959
SW F-stat (1 st Stage) [a]	285.76	285.76	285.76	12,482.25	12,482.25	12,482.25
SW F-stat (1 st Stage) [b]				9,288.69	9,288.69	9,288.69
KP F-stat (1 st Stage)	285.76	285.76	285.76	661.89	661.89	661.89
DV mean	18.40	8.164	10.23	18.40	8.164	10.23
<i>Panel B. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	1.032*** (0.090)	0.355*** (0.064)	0.681*** (0.058)	1.103*** (0.165)	0.423*** (0.135)	0.685*** (0.074)
Distributed Dam Revenues $\times$ Affected [b]				-0.102 (0.218)	-0.099 (0.173)	-0.005 (0.083)
Observations	3,615	3,615	3,615	3,615	3,615	3,615
SW F-stat (1 st Stage) [a]	480.72	480.72	480.72	10,929.39	10,929.39	10,929.39
SW F-stat (1 st Stage) [b]				9,960.93	9,960.93	9,960.93
KP F-stat (1 st Stage)	480.72	480.72	480.72	770.74	770.74	770.74
DV mean	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses cumulative variables as shares of the previous year's total revenues. Panel B expresses cumulative variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.12: Effects on Tax Revenues and Public Expenditures: Alternative IV Using Municipal Population Density as Share

Panel A. First-Stage						
	Distributed Dam Revenues	Distributed Dam Revenues				
Predicted Dam Revenues	0.000*** (0.000)	0.000**** (0.000)				
Predicted Dam Revenues × Affected		0.000*** (0.000)				
Observations	3,791	3,791				
R ²	0.855	0.858				
DV mean	1,792	1,792				
Panel B. Tax Revenue Outcomes						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.210*** (0.070)	0.068** (0.029)	0.130*** (0.041)	0.215*** (0.075)	0.070** (0.032)	0.133*** (0.044)
Distributed Dam Revenues × Affected [b]				-0.101 (0.076)	-0.033 (0.033)	-0.066 (0.046)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	7.40	7.29	7.40	7.15	6.90	7.15
SW F-stat (1 st Stage) [b]				40.23	23.05	40.23
KP F-stat (1 st Stage)	7.40	7.29	7.40	3.51	3.40	3.51
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23
Panel C. Public Expenditure Outcomes						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	1.734*** (0.434)	0.755** (0.321)	0.930*** (0.147)	1.737*** (0.433)	0.755** (0.319)	0.933*** (0.149)
Distributed Dam Revenues × Affected [b]				0.210 (1.110)	0.004 (0.474)	0.194 (0.729)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	8.12	8.12	8.12	8.25	8.25	8.25
SW F-stat (1 st Stage) [b]				11.35	11.35	11.35
KP F-stat (1 st Stage)	8.12	8.12	8.12	3.13	3.13	3.13
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables in millions of 2005 PYG. Panel B expresses variables as shares of the previous year's total revenues. Panel C expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.13: Effects on Tax Revenues and Public Expenditures: Alternative IV Based on Strict Definition in Law of Royalties

<i>Panel A. First-Stage</i>						
	Distributed Dam Revenues	Distributed Dam Revenues				
Predicted Dam Revenues	0.441*** (0.097)	0.939*** (0.108)				
Predicted Dam Revenues $\times$ Affected		-0.647*** (0.107)				
Observations	3,791	3,791				
R ²	0.865	0.874				
DV mean	1,792	1,792				
<i>Panel B. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
Distributed Dam Revenues [a]	0.084*** (0.020)	0.028*** (0.008)	0.049*** (0.013)	0.078*** (0.025)	0.032*** (0.009)	0.045*** (0.016)
Distributed Dam Revenues $\times$ Affected [b]				0.018 (0.032)	-0.008 (0.013)	0.011 (0.020)
Observations	2,731	2,922	2,731	2,731	2,922	2,731
SW F-stat (1 st Stage) [a]	97.49	152.87	97.49	67.22	67.98	67.22
SW F-stat (1 st Stage) [b]				287.37	170.88	287.37
KP F-stat (1 st Stage)	97.49	152.87	97.49	132.39	33.94	132.39
DV mean in 2006	18.40	8.164	10.23	18.40	8.164	10.23
<i>Panel C. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
Distributed Dam Revenues [a]	0.955*** (0.155)	0.413*** (0.108)	0.537*** (0.130)	1.086*** (0.252)	0.474** (0.199)	0.614*** (0.096)
Distributed Dam Revenues $\times$ Affected [b]				-0.204 (0.288)	-0.095 (0.226)	-0.119 (0.164)
Observations	2,970	2,970	2,970	2,970	2,970	2,970
SW F-stat (1 st Stage) [a]	67.28	67.28	67.28	57.54	57.54	57.54
SW F-stat (1 st Stage) [b]				151.80	151.80	151.80
KP F-stat (1 st Stage)	67.28	67.28	67.28	31.39	31.39	31.39
DV mean in 2006	0.136	0.060	0.076	0.136	0.060	0.076

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables in millions of 2005 PYG. Panel B expresses variables as shares of the previous year's total revenues. Panel C expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A1.14: Effects on Reporting Probability

	<i>Reporting Indicator for</i>					
	Total Taxes	Property Taxes	Other Taxes	Total Expenditure	Current Expenditure	Capital Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Predicted Dam Revenues	0.000 (0.000)	0.000 (0.000)	0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)	-0.000 (0.000)
Observations	3,800	3,800	3,800	3,800	3,800	3,800
R ²	0.306	0.239	0.306	0.382	0.382	0.382
DV mean	0.895	0.975	0.895	0.789	0.789	0.789

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Predicted Dam Revenues are expressed in millions of 2005 PYG. Outcomes are indicator variables that equal 1 if municipality i submitted its financial report in year t . All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Table A1.15: Effects on Tax Revenues and Public Expenditures: High-Reporting Municipalities

	<i>Panel A. Tax Revenue Outcomes</i>					
	Total Taxes	Property Taxes	Other Taxes	Total Taxes	Property Taxes	Other Taxes
	(1)	(2)	(3)	(4)	(5)	(6)
Distributed Dam Revenues [a]	0.090*** (0.019)	0.030*** (0.008)	0.054*** (0.012)	0.087*** (0.026)	0.034*** (0.009)	0.053*** (0.017)
Distributed Dam Revenues $\times$ Affected [b]				0.009 (0.032)	-0.008 (0.014)	0.003 (0.021)
Observations	2,639	2,922	2,639	2,639	2,922	2,639
SW F-stat (1 st Stage) [a]	53.35	65.22	53.35	38.13	35.63	38.13
SW F-stat (1 st Stage) [b]				169.44	83.05	169.44
KP F-stat (1 st Stage)	53.35	65.22	53.35	16.84	17.37	16.84
DV mean in 2006	18.28	8.164	10.26	18.28	8.164	10.26
	<i>Panel B. Public Expenditure Outcomes</i>					
	Total Expenditure	Current Expenditure	Capital Expenditure	Total Expenditure	Current Expenditure	Capital Expenditure
	(1)	(2)	(3)	(4)	(5)	(6)
Distributed Dam Revenues [a]	1.017*** (0.202)	0.466*** (0.138)	0.554*** (0.154)	1.338*** (0.308)	0.622** (0.272)	0.717*** (0.095)
Distributed Dam Revenues $\times$ Affected [b]				-0.513 (0.335)	-0.250 (0.273)	-0.260 (0.181)
Observations	2,531	2,531	2,531	2,531	2,531	2,531
SW F-stat (1 st Stage) [a]	60.61	60.61	60.61	252.60	252.60	252.60
SW F-stat (1 st Stage) [b]				266.67	266.67	266.67
KP F-stat (1 st Stage)	60.61	60.61	60.61	31.39	31.39	31.39
DV mean in 2006	0.132	0.058	0.073	0.132	0.058	0.073

Notes: Sample consists of municipalities whose reporting rate is greater than or equal to 0.7. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables per capita terms using the previous year's population. All regressions include municipality and department-year FE. Sample period 2006–2024. Two-way clustered SE by municipality and department-year are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B1 Appendix: Shift-Share IV Construction

B1.1 Step 1: Hydroelectric Dams' Calculation of Dam Revenues

B1.1.1 Itaipu Dam

The Itaipu dam sends money under two categories: payments for electricity use, called royalties, and compensations for transferring electricity from Paraguay to Brazil ([Itaipu Binacional 1973](#)).¹³ In practice, money transfers are made monthly. Given that I have annual data, I do the calculations annually.

Then, the Itaipu royalties are calculated as

$$\text{Itaipu Royalties}_t = \frac{\text{Total Production Supplied}_t^I}{2} \cdot \text{USD Rate}^{IR} \cdot \text{Multiplier Factor}_t^{IR} \cdot \text{Adjustment Factor}_t^I \cdot \text{Exchange Rate}_t \quad (\text{B1.1})$$

where $\text{Total Production Supplied}_t^I$ is the hydroelectric production of the Itaipu dam in Gwh in year t after discounting the energy used by the dam for its own operation, USD Rate^{IR} is a fixed USD rate for the Itaipu royalties set at USD 650 per Gwh, and $\text{Multiplier Factor}_t^{IR}$ is a multiplier factor to the Itaipu royalties in year t that is determined in common agreement between the governments of Paraguay and Brazil. $\text{Adjustment Factor}_t^I$ is an adjustment factor in year t that keeps the US dollar constant. It is based on the percentage change of the annual average index of the industrial goods and consumer prices indices taken from the IMF International Financial Statistics. Exchange Rate_t is the average exchange rate (PYG/USD) in year t ([Itaipu Binacional 1973](#); [Itaipu Binacional 2005-2024](#); [Itaipu Binacional 2005-2024](#); [Banco Central del Paraguay 2025](#)).

Itaipu compensations are computed as

$$\text{Itaipu Compensations}_t = \text{Production to Brazil}_t^I \cdot \text{USD Rate}^{IC} \cdot \text{Multiplier Factor}_t^{IC} \cdot \text{Adjustment Factor}_t^I \cdot \text{Exchange Rate}_t \quad (\text{B1.2})$$

where $\text{Production to Brazil}_t^I$ is the portion of the hydroelectric production of the Itaipu dam belonging to Paraguay and transferred to Brazil in Gwh in year t . It is calculated as $\frac{\text{Total Production Supplied}_t^I}{2} -$

¹³According to the Itaipu Treaty, signed by the governments of Paraguay and Brazil, each country owns 50% of the electricity produced. The Treaty also states that any remaining electricity not used by one of the countries can only be sold to the other country that is part of the Treaty ([Itaipu Binacional 1973](#)). As a small and developing country, Paraguay has not used all of its share in the period 2006–2024.

Production used by Paraguay $_t^I$. USD Rate IC is a fixed USD rate for the Itaipu compensations set at USD 300 per Gwh, and Multiplier Factor $_t^{IC}$ is a multiplier factor to the Itaipu compensations in year t that is determined in common agreement between the governments of Paraguay and Brazil. The rest of the terms are defined as before (Itaipu Binacional 1973; Itaipu Binacional 2005-2024; Itaipu Binacional 2005-2024; Banco Central del Paraguay 2025).

B1.1.2 Yacyreta Dam

The Yacyreta dam provides revenue under two compensation categories: compensations for flooded territory and compensations for the transfer of electricity from Paraguay to Argentina (Entidad Binacional Yacyreta 1973).¹⁴ According to the Yacyreta Treaty, money transfers should be made monthly. I do the calculations annually instead.¹⁵

Yacyreta compensations for flooded territory are then calculated as

$$\begin{aligned} \text{Yacyreta Compensations } 1_t = & \text{Total Production Supply}_t^Y \cdot \text{Unit Cost}^Y \cdot \text{Flooded Territory Factor}^Y \\ & \cdot \text{Paraguay Portion}^Y \cdot \text{Adjustment Factor}_t^Y \cdot \text{Exchange Rate}_t \end{aligned} \quad (\text{B1.3})$$

where Total Production Supply $_t^Y$ is the hydroelectric production of the Yacyreta dam in Gwh in year t after discounting the energy used by the dam for its own operation, Unit Cost Y is an estimated theoretical economic unit cost set at USD 44,500 per Gwh, Flooded Territory Factor Y is a flooded territory factor set at 0.089, and Paraguay Portion Y is the estimated portion of the flooded territory in Paraguay land set at 0.80. Adjustment Factor $_t^Y$ is an adjustment factor in year t that keeps the US dollar constant. It is based on the percentage change of the annual average index of the world export unit value, the export unit value of industrial countries, the US export unit value and the US producer index for the years 2006–2016 and the annual average index

¹⁴As in the case of the Itaipu dam, the Yacyreta Treaty, signed by the governments of Paraguay and Argentina, states that each country owns 50% of the electricity produced. The Treaty also states that any remaining electricity not used by one of the countries can only be sold to the other country that is part of the Treaty (Entidad Binacional Yacyreta 1973). As in the case of the Itaipu electricity, Paraguay has not used all of its share of Yacyreta electricity in the period 2006–2024.

¹⁵Contrary to the Itaipu dam, payments from the Yacyreta dam were made less regularly and under different conditions, including payment deferrals and grace periods that were not well defined. I do not account for these conditions in the calculations. Instead, I compute Yacyreta compensations the government of Paraguay should have received according to the Yacyreta Treaty.

of the US export unit value and the US producer index for the years 2017–2024 from the IMF. Exchange Rate_{*t*} is the average exchange rate (PYG/USD) in year *t* (Entidad Binacional Yacyreta 1973; Entidad Binacional Yacyreta 2006-2007, 2009-2018; Entidad Binacional Yacyreta 2016-2018; Administración Nacional de Electricidad 2006-2024; International Monetary Fund 2006-2024; Banco Central del Paraguay 2025).

Yacyreta compensations for transferring electricity to Argentina are computed as

$$\text{Yacyreta Compensations } 2_t = \text{Production to Argentina}_t^Y \cdot \text{USD Rate}^{YC2} \cdot \text{Adjustment Factor}_t^Y \cdot \text{Exchange Rate}_t \quad (\text{B1.4})$$

where Production to Argentina_{*t*}^Y is the portion of the hydroelectric production of the Yacyreta dam belonging to Paraguay and transferred to Argentina in Gwh in year *t*. It is calculated as $\frac{\text{Total Production Supplied}_t^Y}{2} - \text{Production used by Paraguay}_t^Y$. USD Rate^{YC2} is a fixed USD rate for Yacyreta compensations for the transfer of electricity to Argentina set at USD 2,998 per Gwh. The rest of the terms are defined as before (Entidad Binacional Yacyreta 1973; Entidad Binacional Yacyreta 2006-2007, 2009-2018; Entidad Binacional Yacyreta 2016-2018; Administración Nacional de Electricidad 2006-2024; International Monetary Fund 2006-2024; Banco Central del Paraguay 2025).

B1.2 Step 2: Allocation of Dam Revenues to Different Government Levels

Once the money generated for the exploitation of the two hydroelectric dams is calculated, the next step is to compute the portions that go to municipalities. As described in Section 1.2, municipalities receive two categories of transfers: revenues and FONACIDE. Revenues are comprised of the amounts obtained from equations B1.1, B1.3, and B1.4 for the entire period 2006–2024 and equation B1.2 for the period 2006–2012.¹⁶ FONACIDE, a Fund created in 2012, is obtained from equation B1.2 for the period 2013–2024. According to Laws 1309/1998, 3984/2010 and modifications, 15% of revenues go to affected municipalities and 25% to non-affected municipalities. These percentages were applied gradually from 2000 to 2012. I account for this in the calculations. Law 4758/2012

¹⁶The CGR concluded that the MEF interpreted the Laws of Royalties 1309/1998, 3984/2010 and modifications incorrectly until 2011. According to the CGR, these Laws stated the distribution of revenues from equation B1.1 and B1.3 only, while the MEF also transferred revenues obtained from B1.2 and possibly from equation B1.4 as well (Contraloría General de la República 2005-2024). Therefore, I define the first category of dam revenues including equations B1.3 and B1.4 to obtain a stronger first-stage. Results based on an alternative definition that considers the strict application of the Laws can be found in Appendix Table A1.13.

and modifications state that affected municipalities receive 7.5% and non-affected municipalities receive 12.5% of FONACIDE revenue. By applying these percentages, I obtain the portions of the two categories, revenues and FONACIDE, that go to municipalities.

Chapter 2

Do Local Governments Respond Differently to Intergovernmental Transfers? The Case of Paraguayan Municipalities

2.1 Introduction

Intergovernmental transfers are a central feature of fiscal decentralization. This is particularly true in developing countries where subnational governments rely heavily on external sources of revenue to finance local public goods and services (Bahl and Bird 2018). A large empirical literature has documented that such transfers often translate into increased public spending—a phenomenon known as the flypaper effect—while their impact on local taxation remains understudied (Hines and Thaler 1995; Inman 2008). Much of the literature has focused on the average effects, but little is known about how responses to transfers can vary between local governments depending on their economic structure, institutional capacity, and political incentives. While transfers are particularly salient in developing countries, this heterogeneity in fiscal responses is not exclusive to them. Even within advanced economies, subnational governments may exhibit substantial disparities in these economic and political dimensions, leading to uneven fiscal responses to transfers. Therefore, characterizing this heterogeneity and identifying the local conditions that drive it are critical for evaluating the effectiveness of decentralization policies and assessing whether transfers strengthen or weaken local fiscal capacity.

This chapter builds directly on the findings of Chapter 1, which document average fiscal responses to transfers, showing that hydroelectric dam revenues in Paraguay increase two fiscal margins: municipal public spending and tax collection. These results raise a natural question: do all municipalities respond to transfers in the same way? Paraguay provides a particularly useful setting to answer this question. After the return to democracy in 1989, the country experienced relatively slow economic growth and periods of economic and political instability until the mid-2000s, followed by a phase of stronger and more sustained growth driven by structural reforms and new economic incentives. However, this growth process has been uneven across municipalities, resulting in persistent differences in local economic conditions and institutional capacity. These differences suggest that similar increases in intergovernmental transfers may generate heterogeneous fiscal responses across municipalities, with some expanding both spending and taxation, others relying primarily on transfers to finance expenditures, and others exhibiting weaker responses. Examining this variation is essential for interpreting the average effects documented in Chapter 1 and understanding how fiscal responses differ between municipalities. Therefore, in this chapter, I examine whether differences in political composition, infrastructure and development, economic structure, and demographic characteristics are associated with heterogeneous fiscal responses to dam revenues.

To guide the empirical analysis, I develop a political economy model of local fiscal behavior in which municipalities differ in their effective public goods technology and the political incentives they face. The model introduces a public spending threshold that determines whether municipalities operate in a low- or high-spending regime. Crossing this threshold depends on the preferences and composition of informed voters, while the response of local taxation to transfers depends on the marginal productivity of public spending and the returns to scale of public goods. This framework captures the idea that local governments in less developed environments may remain below the threshold, exhibiting limited fiscal responses and weaker incentives to mobilize revenue, whereas more developed local governments are more likely to operate above it. The model generates three possible equilibria related to the flypaper effect literature: attenuated responses with tax crowd-out, regular one-for-one responses, and amplified responses with tax crowd-in.

To test these predictions, I combine the municipal fiscal dataset introduced in Chapter 1 with additional data on political characteristics, infrastructure, land inequality, and socioeconomic con-

ditions. These data allow me to construct measures that proxy for the key dimensions highlighted by the model, including baseline development, economic structure, and demographic composition. The resulting panel dataset covers Paraguayan municipalities over the period 2006–2024.

Empirically, I implement two complementary approaches. First, I estimate interaction models that allow the causal effect of dam revenues to vary with predetermined municipal characteristics within the same shift-share instrumental variables framework used in Chapter 1. This approach ensures comparability with the average effects estimated in Chapter 1 while allowing for heterogeneity in responses. Second, I estimate mixed-effects models that recover municipality-specific responses to predicted dam revenues, the shift-share instrument constructed in Chapter 1, allowing for unobserved heterogeneity in fiscal behavior. Together, these approaches provide both a causal interpretation of heterogeneity and a descriptive characterization of its distribution across municipalities.

The results reveal heterogeneity in fiscal responses to transfers. Consistent with the theoretical model, municipalities with stronger economic bases, greater urbanization, better infrastructure, and more diversified economic structures tend to exhibit amplified responses, with increases in both local public spending and tax collection. In contrast, more rural and less developed municipalities tend to display weaker responses, indicating tax crowd-out. The mixed-effects estimates further show that municipalities are distributed across distinct response regimes, including cases of symmetric high responses, symmetric low responses, and asymmetric adjustments across the two fiscal margins, municipal public spending and tax collection. These patterns suggest that the effectiveness of transfers depends critically on local conditions that shape both the productivity of public spending and the incentives for revenue mobilization.

This paper makes three contributions to the literature. First, it contributes to the flypaper effect literature by moving beyond average effects and providing evidence on heterogeneous fiscal responses to intergovernmental transfers within a unified empirical framework. While existing work shows that transfers can either crowd in or crowd out local taxation ([Ferraz, Foremny, and Santini 2025](#)), less is known about how these responses vary across local governments and which underlying characteristics explain this heterogeneity. By combining interaction-based estimates with municipality-specific slopes, this paper documents dispersion in fiscal responses and links it to observable local conditions.

Second, the paper contributes to the literature on state capacity and local development by showing that differences in economic structure, infrastructure, and baseline development are key determinants of how municipalities translate transfers into taxation and spending. These findings complement existing work emphasizing that fiscal capacity and the effectiveness of public spending depend on local institutional and economic environments (Besley and Persson 2009; Besley and Persson 2013).

Finally, the paper contributes to the local political economy literature by developing a theoretical framework in which electoral incentives, voter information, and heterogeneous preferences jointly determine fiscal policy. Building on models of political competition and local governance (Baron 1994; Bardhan and Mookherjee 2000; Carter and Morrow 2015), the framework highlights how differences in the composition and preferences of voter groups can generate distinct fiscal equilibria, providing a mechanism for the heterogeneous responses observed in the data.

The remainder of the paper proceeds as follows. Section 2.2 presents the theoretical model. Section 2.3 describes the data. Section 2.4 outlines the heterogeneity analysis. Section 2.5 presents the results. Section 2.6 concludes.

2.2 Theoretical Model

This section develops a political economy model of local fiscal behavior designed to explain why intergovernmental transfers can generate heterogeneous responses in local public spending and tax collection. In the fiscal federalism literature, the flypaper effect refers to the empirical regularity that intergovernmental transfers tend to increase local public spending more than equivalent increases in local income, implying that “money sticks where it hits” (Hines and Thaler 1995; Inman 2008). While this literature has primarily focused on average responses to transfers, the model developed here provides a framework to illustrate how these responses may vary systematically across municipalities. In particular, it characterizes three possible responses to transfers that extend the standard flypaper effect: (i) cases in which transfers raise spending by less than one-for-one and crowd out local taxation (*attenuated flypaper effect*), (ii) cases in which transfers translate almost one-for-one into spending with little change in taxation (*regular flypaper effect*), and (iii) cases in which transfers raise spending by more than one-for-one and are accompanied by increases in local

tax collection (*amplified flypaper effect*).

The model starts with a conventional public goods function with diminishing returns to scale and then allows for discontinuity in the effectiveness of public goods provision. This discontinuity becomes the key assumption in the model. Below a threshold level of public spending, public goods are weakly productive and exhibit diminishing returns. Once a minimum scale is reached, public goods become more effective, either because fixed costs are overcome (e.g., basic infrastructure connectivity or administrative capacity) or because complementarities and network effects are activated. This discontinuity introduces the possibility of regime change. Municipalities may remain trapped in a low-spending equilibrium, transition discretely at the threshold, or operate in a high-spending equilibrium, where additional spending is more politically and economically valuable.

Political incentives determine whether such a transition occurs. Two candidates compete in the mayoral election by proposing tax platforms that determine public spending under a balanced-budget constraint. The incumbent is fiscally conservative and sets a baseline tax platform that keeps spending below the threshold. The opponent chooses a tax platform to maximize electoral success. Informed voters—composed of middle-class and rich citizens—observe policy platforms directly, provide campaign contributions to their preferred candidate, and vote accordingly. Uninformed voters—composed of poor citizens—respond to campaign intensity. Importantly, different informed groups value public goods differently. In many local public goods, such as roads or basic infrastructure, the middle class may experience larger marginal gains than the rich, either because these goods relax binding constraints on economic activity or because the rich rely more on private substitutes.

The model delivers three main insights. First, regime change depends on the informed voters' preferences. When middle-class voters place greater marginal political weight on public goods provision than the rich do, the opponent can optimally induce regime change even when the incumbent remains below the threshold. Second, political composition matters in addition to preferences. Municipalities with a larger share of middle-class voters among informed voters are more likely to cross the threshold. Third, once a spending regime is selected, the response of taxes to transfers depends on the shape of the effective public goods technology, inducing either a decrease, an increase, or no change in tax collection.

2.2.1 Set-Up

Following [Baron 1994](#); [Bardhan and Mookherjee 2000](#) and [Carter and Morrow 2015](#), consider two political parties competing in a mayoral election. Candidate A is the incumbent mayor seeking reelection, while candidate B is an opponent. Each candidate proposes, as part of their policy platform, some level of taxes to be collected T_k for $k \in \{A, B\}$.

Publicly, candidates frame T_k as a commitment to “administrative efficiency” or “enhanced fiscal discipline,” rather than explicitly as higher or lower taxation. Voters thus interpret T_k as a measure of the candidate’s credibility and governance capacity, making it a meaningful part of campaign platforms.

The timing in the model is the following:

1. The incumbent A , as part of their policy platform, chooses a conservative level of taxes T_A .
2. Given T_A , the opponent B chooses T_B .
3. Informed voters observe both levels, decide their monetary contributions for campaign spending, and their voting behavior.
4. Uninformed voters observe only campaign spending and vote accordingly.
5. The candidate with the highest share of votes wins, and the winning platform is implemented.

2.2.1.1 Voters

Voters are divided into three groups: rich (r), middle-class (m), and poor (p). A fraction δ_r of the voting population is rich, a fraction δ_m is middle-class, and the remaining $1 - \delta_r - \delta_m$ is poor. Rich and middle-class voters are informed: they observe both candidates’ policy platforms and respond strategically through monetary contributions. Poor voters are uninformed: they do not observe policy details and instead respond to the scale of campaign spending, which is financed by contributions from the informed.

Informed voters of class $j \in \{r, m\}$ have expected utility $U_k(C_j)$ under each candidate’s platform, where C_j is private consumption. Assume $U'_k(C_j) > 0$ and $U''_k(C_j) < 0$. Private consumption

of informed voters depends on their disposable income

$$C_j = Y_j(P_k, T_k)$$

where Y_j represents informed voters' disposable income that is affected by public goods provided P_k and by paid taxes T_k . Better public goods can raise local productivity, increasing income, particularly for informed voters who may be more connected to market activity, $\frac{\partial Y_j}{\partial P_k} > 0$. Higher taxes in turn reduce disposable income, $\frac{\partial Y_j}{\partial T_k} < 0$.

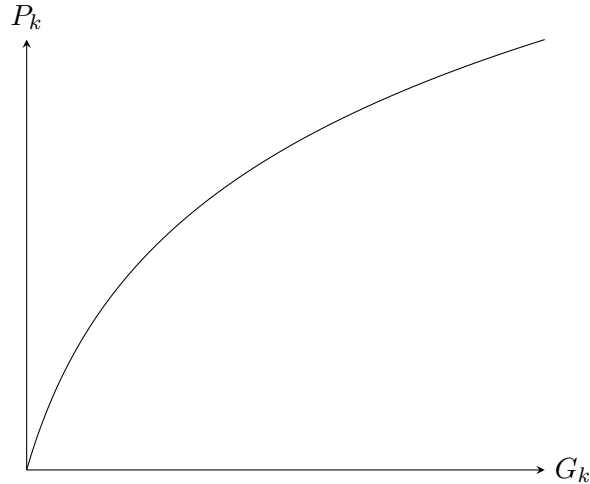
For some public goods, middle-class citizens may experience higher marginal utility than rich citizens, either because these goods relax binding constraints on economic activity or because rich voters rely more on private substitutes. This possibility is captured in the model by assuming that $\frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_k} \geq \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial P_k}$.

Formally, public goods are produced using local public spending G_k . Define the public goods technology P_k as

$$P_k = f(G_k), \quad f'(G_k) > 0, \quad f''(G_k) < 0$$

where public goods increase with public spending ($f'(G_k) > 0$) and exhibit diminishing returns to scale ($f''(G_k) < 0$) as shown in Figure 2.1.

Figure 2.1: Public Goods Function



Contributions from informed voters to Candidate k are motivated by the utility differential under each candidate's platform. This differential can be seen as the willingness to support one

candidate over the other. For $j \in \{r, m\}$, let the utility differential between candidate B and A be

$$\Delta U_j \equiv U_B(C_j) - U_A(C_j)$$

Then, the total contributions for candidate B are

$$D_B = \sum_{j \in \{r, m\}} \delta_j D_{B,j}(\Delta U_j) = \delta_r D_{B,r}(\Delta U_r) + \delta_m D_{B,m}(\Delta U_m)$$

Similarly, total contributions for candidate A can be defined considering the willingness to support candidate A relative to B as $-\Delta U_j$.

Uninformed voters' preferences are not modeled directly through utility functions because they do not evaluate policy platforms. Instead, their voting behavior depends on the relative scale of campaign activity, summarized by the campaign-response function $H(D_B - D_A)$. This simplification keeps the focus on how informed voters' preferences and contributions shape equilibrium fiscal behavior.

2.2.1.2 Local Government Budget Constraint

Each candidate faces the local government's budget constraint

$$G_k = R + M(T_k),$$

where R are intergovernmental transfers and $M(T_k) = T_k - L(T_k)$ denotes net locally generated revenues after accounting for administrative costs $L(T_k)$ and is increasing in T_k . Because local governments fully allocate available resources to spending, this constraint holds with equality.

2.2.1.3 Candidate B's Problem

Candidate B is the relevant decision-maker in this model because they strategically select their policy platform to improve their chances of defeating the incumbent, internalizing how both informed and uninformed voters react to fiscal choices. Candidate B takes the incumbent's level of taxes T_A

as given and chooses T_B to maximize their expected probability of winning, V_B

$$\begin{aligned} \max_{T_B} \quad V_B = & \Pi(\delta_r I_r(U_B(C_r) - U_A(C_r)) + \delta_m I_m(U_B(C_m) - U_A(C_m))) \\ & + (1 - \delta_r - \delta_m)H(D_B - D_A)) \quad \text{s.t.} \quad G_B = R + M(T_B) \end{aligned}$$

where $\Pi(\cdot)$ is the increasing expected probability function of winning, $I_j(\cdot)$ captures informed voters' responsiveness to utility differences, and $H(\cdot)$ captures the uninformed's responsiveness to campaign spending differences.

2.2.2 Equilibrium

The first-order condition for an interior solution is

$$\frac{dV_B}{dT_B} = \underbrace{[A_G^{\text{inf}} + A_G^{\text{uninf}}] M'(T_B^*)}_{\text{Marginal political benefit of public goods}} + \underbrace{[B_T^{\text{inf}} + B_T^{\text{uninf}}]}_{\text{Marginal political cost of taxation}} = 0$$

where

$$\begin{aligned} A_G^{\text{inf}} &= \delta_r \cdot \frac{dI_r}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial P_B} \cdot f'(G_B) \cdot \frac{\partial G_B}{\partial M(T_B)} \\ &\quad + \delta_m \cdot \frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B} \cdot f'(G_B) \cdot \frac{\partial G_B}{\partial M(T_B)} > 0 \\ A_G^{\text{uninf}} &= (1 - \delta_r - \delta_m) \cdot \frac{dH}{d\Delta D} \cdot \left(\delta_r \cdot \frac{d\Delta D}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial P_B} \cdot f'(G_B) \cdot \frac{\partial G_B}{\partial M(T_B)} \right. \\ &\quad \left. + \delta_m \cdot \frac{d\Delta D}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B} \cdot f'(G_B) \cdot \frac{\partial G_B}{\partial M(T_B)} \right) \geq 0 \\ B_T^{\text{inf}} &= \delta_r \cdot \frac{dI_r}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial T_B} + \delta_m \cdot \frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial T_B} < 0 \\ B_T^{\text{uninf}} &= (1 - \delta_r - \delta_m) \cdot \frac{dH}{d\Delta D} \cdot \left(\delta_r \cdot \frac{d\Delta D}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial T_B} + \delta_m \cdot \frac{d\Delta D}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial T_B} \right) \leq 0 \\ M'(T_B) &= \frac{dM(T_B)}{dT_B} > 0 \end{aligned}$$

A_G^{inf} and A_G^{uninf} capture the weighted marginal political benefits of public goods through its impact on the utility of informed voters and the responsiveness of uninformed voters to campaign contributions, while B_T^{inf} and B_T^{uninf} capture the weighted marginal political costs of taxation on those same groups of voters. Thus, the first term of the first-order condition can be summarized as the marginal political benefit of public goods and the second term the marginal political cost of

taxation.

2.2.3 Effective Public Goods

So far, the model assumed a conventional public goods function with a positive but decreasing relationship between public goods and public spending. It is possible, however, that this behavior does not apply to all local governments. Additional spending may generate increasing returns to scale in public goods in certain municipalities once spending reaches some threshold and public goods become “effective” (e.g., due to a minimum level of infrastructure connectivity or administrative capacity attained). To account for this possibility, I redefine the public goods function as an effective public goods technology P_k in the following way

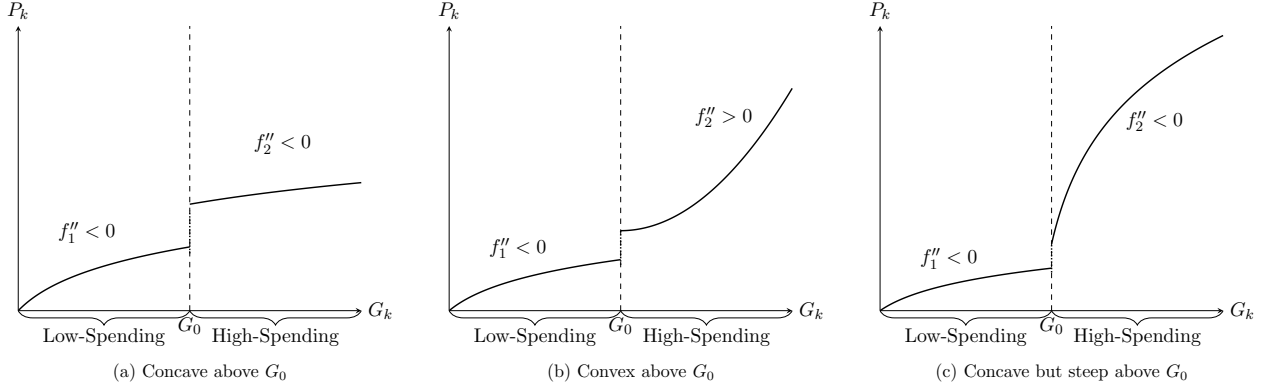
$$P_k = \begin{cases} f_1(G_k), & G_k < G_0, & f'_1(G_k) > 0, f''_1(G_k) < 0 \\ f_2(G_k), & G_k \geq G_0, & f'_2(G_k) > 0, f''_2(G_k) \leq 0 \end{cases}$$

I assume the function exhibits a discrete jump at the spending threshold G_0 with $f_2(G_0) > f_1(G_0)$. This threshold is the minimum level of spending required for public goods to be effective. I define the region below G_0 as the low-spending region and above G_0 as the high-spending region, as shown in Figure 2.2. Above the threshold, $f''_2(G_k)$ may be negative (Figure 2.2, Panels (a) and (c)) or positive (Figure 2.2, Panel (b)), allowing for either diminishing or increasing returns due to network effects or complementarities. In addition, the marginal productivity of public spending may differ across regions. In particular, even if both $f_1(G_k)$ and $f_2(G_k)$ are concave, the high-spending region may be locally steeper, i.e. $f'_2(G_k) > f'_1(G_k)$ for $G_k \geq G_0$ (Figure 2.2, Panel (c)), allowing for larger responses just above the threshold.

2.2.3.1 Equilibrium

Because the public goods technology is now discontinuous at the threshold G_0 , candidate B 's maximization problem is divided into three regions: a low-spending region with $G_B < G_0$, a threshold region with $G_B = G_0$ and a high-spending region with $G_B > G_0$. Within the low- and high-spending regions, the objective function is smooth and standard first-order conditions characterize local optima. In the threshold region, the objective function is discontinuous and

Figure 2.2: Discontinuous Public Goods Function



optimality is determined by a global comparison.

1. **Low-Spending Region** ($G_B < G_0$): Public goods are produced according to $P_B = f_1(G_B)$ with diminishing returns, $f'_1(G_B) > 0$ and $f''_1(G_B) < 0$.

The first-order condition for an interior solution within the low-spending region is

$$\frac{dV_B}{dT_B} = \underbrace{\left[A_{G,1}^{\text{inf}} + A_{G,1}^{\text{uninf}} \right] M'(T_B^*)}_{\text{Marginal political benefit of public goods}} + \underbrace{\left[B_T^{\text{inf}} + B_T^{\text{uninf}} \right]}_{\text{Marginal political cost of taxation}} = 0$$

where $A_{G,1}^{\text{inf}}$ and $A_{G,1}^{\text{uninf}}$ are defined analogously to the conventional public goods function case, replacing $f'(G_B)$ with $f'_1(G_B)$. B_T^{inf} and B_T^{uninf} are defined as before.

2. **Threshold Region** ($G_B = G_0$): The public goods production function, $P_B = f_2(G_0)$, is not differentiable at G_0 . Candidate B may find it optimal to select the tax level that just allows public spending to reach the threshold.

$$T_B^* = T_0, \quad \text{such that} \quad G_0 = R + M(T_0)$$

At $T_B^* = T_0$, public goods provision exhibits a discrete upward jump

$$\Delta P_0 \equiv f_2(G_0) - f_1(G_0) > 0$$

where ΔP_0 measures the size of the discontinuity in public goods at the threshold.

Because public goods enter voters' income and utility, this jump induces a discrete increase in informed voters' utility and campaign contributions, which in turn raises the support of uninformed voters through campaign spending. As a result, the opponent's objective function is discontinuous at T_0 and is not characterized by a first-order condition. Instead, it is optimal if the discrete gain from crossing the threshold dominates the cost of raising taxes to reach it. Intuitively, the opponent compares the best achievable electoral outcome in the low-spending region with the outcome from just crossing the threshold. When the discrete gain is sufficiently large, the opponent optimally chooses to reach the threshold even if a local interior optimum exists below it.

3. **High-Spending Region** ($G_B > G_0$): Once the threshold is crossed, public goods are produced according to $P_B = f_2(G_B)$ with $f'_2(G_B) > 0$ and $f''_2(G_B) \leq 0$.

An interior optimum in the high-spending region satisfies

$$\frac{dV_B}{dT_B} = \underbrace{[A_{G,2}^{\text{inf}} + A_{G,2}^{\text{uninf}}]}_{\text{Marginal political benefit of public goods}} M'(T_B^*) + \underbrace{[B_T^{\text{inf}} + B_T^{\text{uninf}}]}_{\text{Marginal political cost of taxation}} = 0$$

where $A_{G,2}^{\text{inf}}$ and $A_{G,2}^{\text{uninf}}$ are defined analogously to the low-spending case, replacing $f'_1(G_B)$ with $f'_2(G_B)$. B_T^{inf} and B_T^{uninf} are defined as before.

As in the low-spending region, candidate B obtains political gains from providing public goods that raise informed voters' income and utility. This also increases their contributions, persuading the uninformed. These gains are offset by the tax burden imposed on informed voters, which also affects uninformed voters through campaign contributions.

Above the threshold, public goods can exhibit standard diminishing returns, in which additional government spending provides more public goods at a decreasing rate. Nevertheless, increasing returns to public goods can also arise because each additional unit of spending can exploit network effects and complementarities with private activity. Once the threshold is reached (e.g., a road connecting the port or the main cities), additional spending can exploit that network (more traffic, more trade). At the same time, as G_B increases, firms and households may invest more. Thus, the marginal payoff of additional spending can rise at an

increasing rate.

2.2.4 Extensions

The solutions derived above characterize the opponent's optimal tax choice conditional on remaining within a given spending regime. Whether the equilibrium policy chosen by candidate B lies below the threshold, exactly at the threshold, or above it depends on a global comparison of expected electoral outcomes across regions. In particular, changes in the preferences or political composition of informed voters can affect the opponent's incentives to cross the spending threshold. Once the spending regime is selected, the optimal tax response to additional intergovernmental transfers will vary depending on the relevant effective public goods function. This subsection explores these possibilities.

2.2.4.1 Preferences, Political Composition and Threshold Crossing

I begin by characterizing the political conditions under which the opponent finds it optimal to cross the spending threshold G_0 , increasing their probability of winning the election.

The incumbent is assumed to be fiscally conservative. They choose a level of tax collection T_A such that $G_A = R + M(T_A) < G_0$, keeping public spending below the threshold G_0 , in the low-spending region.

For the opponent, crossing the threshold entails raising taxes sufficiently to induce public spending $G_B \geq G_0$. Whether doing so is electorally optimal depends on a global comparison between (i) the best achievable electoral outcome while remaining below the threshold and (ii) the outcome associated with crossing into the high-spending region. This comparison depends on the size of the discrete jump in public goods at G_0 and on how different groups of informed voters value that jump. As mentioned above, in many local public goods, such as roads or basic infrastructure, the middle class may experience larger marginal gains than the rich, either because these goods relax binding constraints on economic activity or because richer voters rely more on private substitutes. Consequently, an increase in public goods provision can generate a higher marginal utility for the middle class than for the rich, and a disproportionately large electoral response from middle-class voters relative to rich voters. The following proposition formalizes this idea by showing that, when middle-class voters place greater marginal political weight on public goods provision, the discrete

electoral payoff from crossing the threshold is amplified, making regime change more likely even when the incumbent remains below the threshold.

Proposition 1: Preferences and Threshold Crossing. *Consider an incumbent who remains in the low-spending region with $G_A < G_0$. Suppose that middle-class voters place greater marginal political weight on public goods provision than the rich in the sense that the electoral responsiveness-weighted marginal utility gain from public goods is larger for the middle class than for the rich, $\frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B} \geq \frac{dI_r}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial P_B}$. Define the marginal political weight of middle-class voters on public goods as $\omega_m \equiv \frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B}$. Then, there exists a critical distance to the threshold $\bar{\Delta}(\omega_m)$ such that the opponent finds it electorally optimal to cross the threshold G_0 . Moreover, $\bar{\Delta}(\omega_m)$ is weakly increasing in ω_m , $\frac{d\bar{\Delta}(\omega_m)}{d\omega_m} \geq 0$. Hence, when middle-class voters value public goods more at the margin, the opponent can cross the threshold from farther below G_0 , making threshold crossing more likely all else equal.*

Proof. See Appendix B2. □

Define now the share of middle-class voters among informed voters as

$$\tilde{\delta} \equiv \frac{\delta_m}{\delta_m + \delta_r} \in [0, 1], \quad \delta_I \equiv \delta_r + \delta_m$$

Holding the total informed share δ_I fixed, an increase in $\tilde{\delta}$ shifts the political weight from rich to middle-class voters. Given that middle-class voters place relatively greater political weight on public goods provision, as shown in Proposition 1, a higher $\tilde{\delta}$ increases the electoral outcome of entering the high-spending region. As a result, the opponent can defeat the incumbent by choosing a policy that crosses the threshold into the high-spending region, even though the incumbent remains below it. Equivalently, for each political composition $\tilde{\delta}$, there exists a critical distance to the threshold such that crossing becomes electorally viable for candidate B. These conditions are summarized in Proposition 2.

Proposition 2: Political Composition and Threshold Crossing. *Let $\tilde{\delta} \equiv \frac{\delta_m}{\delta_m + \delta_r} \in [0, 1]$ denote the share of middle-class voters among informed voters, holding the total informed share $\delta_I \equiv \delta_r + \delta_m$ fixed. Consider an incumbent who remains in the low-spending region with $G_A < G_0$. Suppose that the opponent's relative electoral outcome from crossing the threshold G_0 compared to*

remaining below it is weakly increasing in $\tilde{\delta}$. Then, there exists a critical distance to the threshold $\bar{\Delta}(\tilde{\delta})$ such that the opponent finds it electorally optimal to cross it. Moreover, $\bar{\Delta}(\tilde{\delta})$ is weakly increasing in $\tilde{\delta}$, $\frac{d\bar{\Delta}(\tilde{\delta})}{d\tilde{\delta}} \geq 0$. Hence, municipalities with a larger middle-class share among informed voters allow the opponent to cross the threshold from farther below G_0 . Equivalently, other things equal, a higher middle-class share among informed voters makes it more likely that the opponent crosses the threshold, while municipalities with a lower middle-class share are more likely to remain in the low-spending region.

Proof. See Appendix B2. □

2.2.4.2 Policy Platforms and Intergovernmental Transfers

Propositions 1 and 2 characterize the opponent's regime selection decision through which they decide whether it is electorally optimal to cross the spending threshold G_0 given the preferences and political composition of voters. In particular, they show that the threshold is more likely to be crossed when either middle-class voters place more political weight on public goods provision (a higher ω_m) or when the middle-class share among informed voters is larger (a higher $\tilde{\delta}$) relative to the rich. Conditional on a region being selected, however, the opponent's tax incentives respond differently to intergovernmental transfers. Proposition 3, therefore, takes the spending region as given and characterizes how changes in transfers change the opponent's optimal tax choice within the low- and high-spending regions, with the direction of the response governed by the marginal productivity and shape of the effective public goods technology in the relevant region.

Proposition 3: Heterogeneous Responses to Intergovernmental Transfers. *Suppose the opponent's optimal policy admits an interior solution within a given spending region. Then, the effect of intergovernmental transfers R on the opponent's optimal tax choice depends on the marginal productivity and shape of the public goods technology in the relevant region. (i) If the opponent remains in the low-spending region ($G_B < G_0$), where public goods are produced under diminishing returns, intergovernmental transfers weakly crowd out local tax collection, $\frac{\partial T_B^*}{\partial R} \leq 0$. (ii) If the opponent operates in the high-spending region ($G_B > G_0$), then the effect of transfers on the opponent's optimal tax choice depends on how the marginal political benefit of public goods varies with R in that region. Under diminishing returns, transfers weakly crowd out taxes, $\frac{\partial T_B^*}{\partial R} \leq 0$.*

In contrast, transfers can crowd in taxes, $\frac{\partial T_P^*}{\partial R} > 0$, either (a) under increasing returns above G_0 due to complementarities or network effects, or (b) even under diminishing returns if the marginal political benefit of public goods is locally increasing just above G_0 (i.e., because $f'_2(G_B)$ is sufficiently steep near G_0).

Proof. See Appendix B2. □

The model's predictions can be connected to the flypaper effect literature. Within a given spending regime, Proposition 3 characterizes how transfers shift the opponent's incentives to raise local taxes. In the low-spending region, where public goods are weakly productive and exhibit diminishing returns, transfers raise public spending by less than one-for-one and local taxation is crowded out, generating an *attenuated flypaper effect*. In the high-spending region, transfers increase spending by more than one-for-one and local tax collection increases when the marginal political benefit of public goods is increasing in transfers, either because returns are increasing or because productivity is sufficiently steep just above G_0 . This corresponds to an *amplified flypaper effect*. In addition, the discontinuity at G_0 implies a *regular flypaper effect* at the point of regime change. When the opponent finds it optimal to just reach the threshold, a discrete increase in spending delivers a discrete increase in effective public goods, with little scope for additional marginal adjustment at that kink.

It is also useful to distinguish between no transition, transition, and post-transition dynamics. A municipality may remain below G_0 in the low-spending region, implying no transition and a weak response of both spending and taxation to transfers. Alternatively, transfers may move it close enough to the spending threshold that the opponent finds it optimal to cross G_0 once, generating a discrete jump in effective public goods and a discrete fiscal adjustment (reaching T_0) with little marginal change in local tax. This corresponds to a transition stage. After crossing the threshold, subsequent increases in transfers operate in the high-spending region. Depending on whether marginal returns are increasing or sufficiently steep near G_0 , transfers can induce additional taxes and amplify spending in a post-transition stage.

2.3 Data

Before describing the data used in the empirical analysis, it is useful to briefly recall the most relevant features of the institutional setting.¹ Municipalities in Paraguay rely heavily on intergovernmental transfers, particularly hydroelectric dam revenues, which represent the largest component of total municipal income (Ministerio de Economía y Finanzas 2025). These transfers are distributed according to a legally predetermined formula that combines equal shares and population-based components, and are subject to earmarking rules that constrain their use, especially for capital spending. The formula also considers the classification of municipalities into affected and non-affected groups, depending on whether they are located near the hydroelectric dams (Poder Legislativo 1998; Poder Legislativo 2010; Poder Legislativo 2012). At the same time, municipalities differ in their level of development, infrastructure, economic structure, and fiscal capacity. These differences are likely to affect both their ability to mobilize local revenues and the effectiveness of public spending. As a result, similar increases in dam revenues may generate different fiscal responses across municipalities, providing a natural setting to study heterogeneous effects.

The theoretical framework developed in Section 2.2 highlights that such heterogeneous fiscal responses to intergovernmental transfers arise from differences in preferences, political composition, and the effectiveness of public spending across municipalities. To bring these mechanisms to the data, I combine the municipal fiscal dataset introduced in Chapter 1 with additional sources that capture these underlying dimensions.

Municipal Elections. I consider electoral data from the 2001, 2006, 2010, 2015, and 2021 municipal elections to explore possible different effects explained by political variables. This dataset comes from the Paraguayan Superior Electoral Court (TSJE, Tribunal Superior de Justicia Electoral). The TSJE provides information on candidates' names, gender, age, political party affiliation, and the number of votes received.

Land Distribution. I use land distribution data to construct a Gini coefficient-type index that measures land inequality. This index enables me to investigate differential impacts across levels of land inequality. I have land data from the 2008 and 2022 National Agricultural Census conducted by the Ministry of Agriculture and Livestock (MAG, Ministerio de Agricultura y Ganadería). The

¹More details of the institutional setting can be found in Chapter 1.

Census contains municipal-level data on quantity and area in hectares. The limitation of this source is that it provides information only for rural areas.

Road Infrastructure. I use data on paved routes from the Ministry of Public Works and Communications (MOPC, Ministerio de Obras Públicas y Comunicaciones) to measure road connectivity. Data is available for the years 2001, 2009, 2011, 2012, 2014, 2017, 2019, and 2021.

Socioeconomic Characteristics. Finally, I consider socioeconomic characteristics at the municipal level from the 2002, 2012, and 2022 National Censuses run by the National Institute of Statistics (INE, Instituto Nacional de Estadística). From the 2002 Census, I use data on workers by economic sector. From the 2002 and 2022 Censuses, I use data on population in urban/rural areas, foreign population, housing type, and the Unsatisfied Basic Needs index, which measures housing quality, sanitary infrastructure, access to education, and subsistence capacity. From the 2012 Census, I have data only on the Unsatisfied Basic Needs index.²

2.4 Heterogeneity Analysis

This section describes the empirical approaches to examine whether the effects of dam revenues on local public finance outcomes vary across municipalities. The theoretical model developed in Section 2.2 predicts that heterogeneous responses arise from differences in preferences for public goods, political composition, and the effectiveness of public spending, which jointly determine whether municipalities remain in a low-spending regime, transition at the threshold G_0 , or operate in a high-spending regime. These differences suggest that the impact of transfers on both spending and taxation may depend on underlying municipal characteristics.

To evaluate these predictions, I implement two complementary empirical approaches. First, I estimate interaction specifications that allow the causal effect of dam revenues to vary with predetermined municipal characteristics, motivated by the theoretical model. Second, I estimate a mixed-effects model that allows the response to predicted dam revenues, the instrument constructed in Chapter 1, to vary across municipalities by estimating municipality-specific slopes. Together, these approaches provide complementary evidence on which observable municipal characteristics

²The 2012 Census presented challenges in its organization and implementation. This resulted in a nationwide population coverage of approximately 74%, limiting the estimation of socioeconomic characteristics at the municipal level ([Dirección General de Estadística, Encuestas y Censos 2012](#)).

are associated with heterogeneous fiscal responses and how these responses are distributed across municipalities.

2.4.1 Interaction Effects

The theoretical model implies that intergovernmental transfers can generate heterogeneous fiscal responses across municipalities for two main reasons. First, municipalities may differ in their propensity to cross the spending threshold G_0 . As shown in Propositions 1 and 2, threshold crossing depends on preferences for public goods and the political composition of informed voters, which determine the marginal political weight placed on public goods provision. Second, conditional on the spending regime, the tax response to transfers depends on the effective public goods technology governing public spending above the threshold, as described in Proposition 3. In particular, municipalities where public spending becomes more productive may exhibit stronger or even positive tax responses to transfers. These predictions suggest that heterogeneous fiscal responses may be related to predetermined municipal characteristics that capture political composition, baseline development, economic structure, and demographic composition.

To test these implications, I interact dam revenues with predetermined municipal characteristics in the main 2SLS specifications introduced in Chapter 1. I begin with the reduced form, which directly estimates heterogeneity in the response to the shift-share instrument, predicted dam revenues

$$Y_{idt} = \alpha_1 R_{idt}^P + \alpha_2 (R_{idt}^P \times W_{id,p-1}) + \delta_i + \mu_{dt} + \nu_{idt} \quad (2.1)$$

where Y_{idt} is an outcome of interest in municipality i of department d in year t . Outcomes of interest include local taxes and public expenditure. R_{idt}^P denotes predicted dam revenues, the instrument used in Chapter 1. The variable $W_{id,p-1}$ represents the most recently observed value of a predetermined municipal characteristic measured prior to period p (e.g., the previous election, census, or survey wave). For annually observed variables, I use the one-year lag. Equation 2.1 also includes δ_i and μ_{dt} to control for municipality and department-year fixed effects, respectively. The error term is given by ν_{idt} . Standard errors are clustered two-way by municipality and department-year.

To recover causal heterogeneous effects, I then estimate the corresponding heterogeneous 2SLS specification

$$Y_{idt} = \beta_1 R_{idt} + \beta_2 (R_{idt} \times W_{id,p-1}) + \delta_i + \mu_{dt} + \varepsilon_{idt} \quad (2.2)$$

where R_{idt} represents distributed dam revenues of municipality i of department d in year t . Because R_{idt} is potentially endogenous for reasons explained in Chapter 1, both R_{idt} and the interaction term $R_{idt} \times W_{id,p-1}$ are instrumented using R_{idt}^P and $R_{idt}^P \times W_{id,p-1}$, respectively. The remaining variables are defined as before. The coefficient β_2 measures how the effect of dam revenues varies with the municipal characteristic $W_{id,p-1}$. The marginal effect of dam revenues is then given by $\beta_1 + \beta_2 W_{id,p-1}$.

As in Chapter 1, I consider an alternative specification that adds the interaction term $R_{idt}^P \times \text{Affected}$ in the reduced-form specification and as an instrument for $R_{idt} \times \text{Affected}$ in the 2SLS specification. This interaction term accounts for differences in how the formula translates aggregate shocks into revenues across affected and non-affected municipalities, allowing the effects to differ by group.

The variables $W_{id,p-1}$ are constructed to capture four dimensions connected to the theoretical model. First, political variables proxy for the political composition determining fiscal policy and thus the likelihood that municipalities cross the minimum spending threshold G_0 . Second, infrastructure and development variables capture baseline conditions. Third, economic structure variables proxy for complementarities between public spending and local economic activity that may affect the marginal productivity of public goods. Finally, demographic composition variables capture differences in population structure that may influence preferences for public goods and the political response to transfers. When variables are available only intermittently (e.g., census or electoral data), they are treated as predetermined and allowed to vary discretely over time, while higher-frequency variables are included in lagged form.

Following the same sample restrictions as in Chapter 1, the sample includes municipalities that existed in 2005 and did not change status from non-affected to affected during 2006–2024, to address potentially endogenous political connections arising from the creation of new municipalities and the reclassification of some municipalities from non-affected to affected. I also exclude Asunción, the

country's capital, because this municipality is much larger than the others in terms of population and annual budget. My sample then consists of 200 municipalities that were either always affected or non-affected throughout the period. Of this total, 48 municipalities are affected and 152 are non-affected.

2.4.2 Mixed-Effects Model

I next estimate a mixed-effects model that allows the response to predicted dam revenues to vary across municipalities. This second approach is closely aligned with the regime-switching logic of the theoretical model. In the model, municipalities differ in their (unobserved) proximity to the spending threshold G_0 and in the effectiveness of public spending above that threshold. Hence, municipalities with similar observable characteristics may still exhibit different fiscal responses to transfers. The mixed-effects specification captures this residual heterogeneity by allowing the response to predicted dam revenues to vary across municipalities, summarizing the distribution of municipality-specific reduced-form effects.

Mixed-effects models are characterized by including both fixed effects and random effects. Fixed effects capture systematic relationships that are common to all municipalities, while random effects allow slopes to vary across municipalities according to a specified distribution, thereby capturing unobserved heterogeneity (see, e.g., [Laird and Ware 1982](#); [Raudenbush and Bryk 2002](#) and [Gelman and Hill 2007](#)). More specifically, I estimate the following reduced-form model

$$Y_{idt} = \beta_{1i} R_{idt}^P + \mu_{dt} + \varepsilon_{idt} \quad (2.3)$$

where the municipality-specific slope β_{1i} is decomposed as

$$\beta_{1i} = \beta_{10} + \sigma_{1i}$$

The term β_{10} represents the average response to predicted dam revenues among municipalities, while σ_{1i} captures municipality-specific deviations from this average. I assume that the random slopes satisfy $\sigma_{1i} \sim \mathcal{N}(0, \sigma_{\sigma_1}^2)$ and are independently distributed across municipalities. The idiosyncratic error term satisfies $\varepsilon_{idt} \sim \mathcal{N}(0, \sigma^2)$ and is independent of the random effects. These

assumptions follow the standard formulation of linear mixed-effects models (Laird and Ware 1982; Gelman and Hill 2007). The specification includes department-year fixed effects but does not include municipality fixed effects, as heterogeneity across municipalities is captured by the random-coefficients structure. The remaining variables are defined as before. Standard errors are clustered at the municipality level. Here I also consider an alternative specification that adds the interaction term $R_{idt}^P \times \text{Affected}$ in the reduced-form specification. My sample again consists of the 200 municipalities that were either always affected or non-affected throughout the period 2006–2024.

Municipality-specific slopes are estimated using empirical Bayes methods (BLUPs, Best Linear Unbiased Predictors), which partially pool information across municipalities and shrink estimates toward the overall mean when data are limited (Laird and Ware 1982; Raudenbush and Bryk 2002; Gelman and Hill 2007). Thus, these estimates summarize underlying heterogeneity in reduced-form responses rather than providing municipality-specific causal effects.

2.5 Results

In this section, I present the empirical results of the chapter. First, I show the interaction-based heterogeneous effects of dam revenues on tax and expenditure outcomes. Next, I complement this evidence by examining the distribution of these responses across municipalities estimated from mixed-effects models.

2.5.1 Interaction Effects

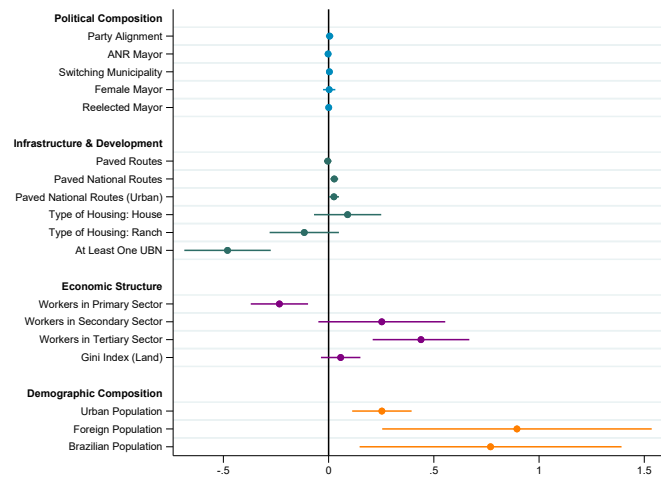
Figures 2.3 and 2.4 plot the estimated interaction coefficients from equation 2.2, which capture how the effect of dam revenues on tax and expenditure outcomes varies with each municipal characteristic.³ Each point represents the estimated coefficient β_2 , while horizontal lines denote 95% confidence intervals. For dummy variables, the coefficient measures the difference in the fiscal response to dam revenues between municipalities with and without the characteristic. For continuous variables, the coefficient indicates how the fiscal response varies with the value of the municipal characteristic. The figures group variables according to the four dimensions connected to the theoretical model: political composition, infrastructure and development, economic structure, and

³Reduced-form results on main outcomes (total taxes and total expenditures) are reported in Appendix Figure A2.1).

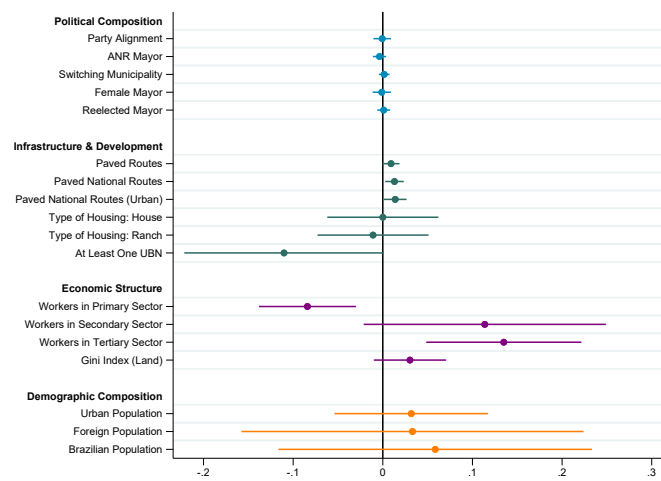
demographic composition. Political composition variables include whether the elected mayor and the president’s political parties are the same, whether the elected mayor is from the ANR party (the dominant party in the country), whether the outgoing and incoming elected mayors are from different political parties, whether the elected mayor is a woman, and whether the winning mayor was ever elected. Variables in infrastructure and development include whether municipalities have paved routes, paved national routes, or paved national routes in urban areas; the share of households living in a house or ranch in 2002; and the share of households with at least one unsatisfied basic need in 2002. The variables of economic structure include the composition of workers in the primary, secondary, and tertiary sectors in 2002, and a Gini-type index measuring land inequality in rural areas constructed from the 2008 and 2022 Agricultural Censuses. Finally, the demographic composition consists of the shares of urban, foreign, and Brazilian populations in 2002 (Brazilians are the largest migrant population in the country). Variables that are measured using 2002 census values can be interpreted as baseline conditions. In models that estimate the effects on taxes, outcomes and dam revenues are measured as percentages of the previous year’s total revenues so that coefficients can be interpreted in percentage points (p.p.), while in models that estimate the effects on expenditure outcomes, coefficients measure municipalities’ marginal propensity to spend out of dam revenues. The sample period is 2006–2024, except for the models that estimate the heterogeneous effects of land inequality. For these models, the sample period is 2009–2024.

Several patterns emerge from the heterogeneous effects estimates on tax and expenditure outcomes. First, political variables display little systematic heterogeneity in the fiscal response to dam revenues. Across the various tax and expenditure outcomes, the interaction coefficients associated with party alignment between the mayor and the president, the mayor’s ANR party affiliation, political turnover, the mayor’s gender, and the mayor’s reelection are generally small and statistically indistinguishable from zero, with two exceptions. The first is a slight increase in current expenditures of about 0.05 per additional Paraguayan Guaraní (PYG) of dam revenues, significant at the 5% level, in switching municipalities compared to municipalities where the incoming and outgoing mayors belong to the same political party. The second is a slight decrease in capital expenditures of about 0.06 per additional PYG of dam revenues, significant at the 10% level, in municipalities where the elected mayor is a woman rather than a man. Yet the general patterns suggest that differences in political variables do not strongly affect the fiscal response to transfers.

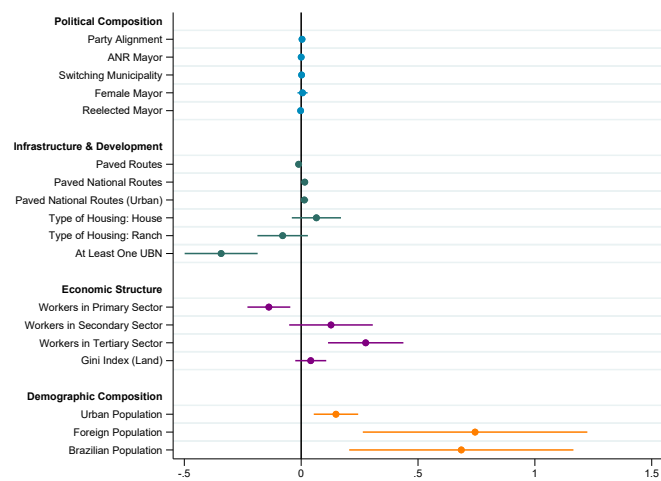
Figure 2.3: Heterogeneous Effects: Tax Outcomes



(a) Total Taxes

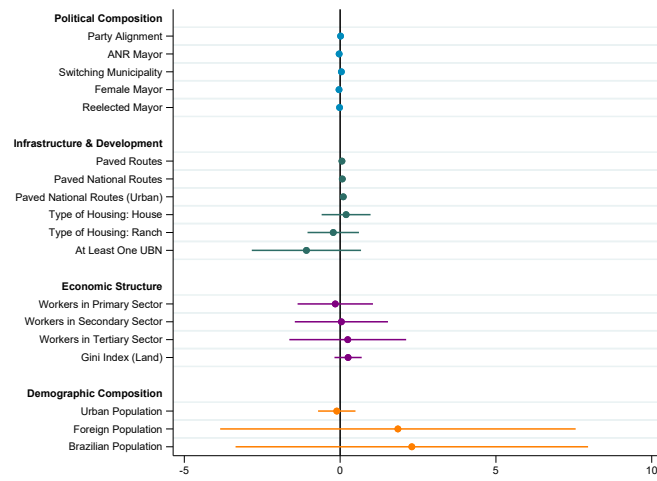


(b) Property Taxes

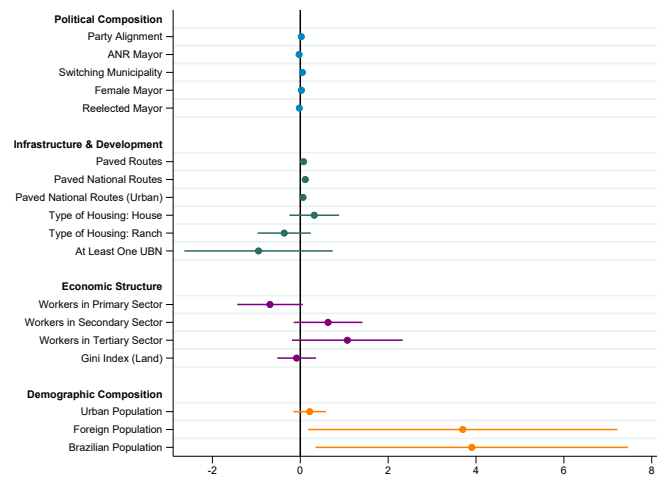


(c) Other Taxes

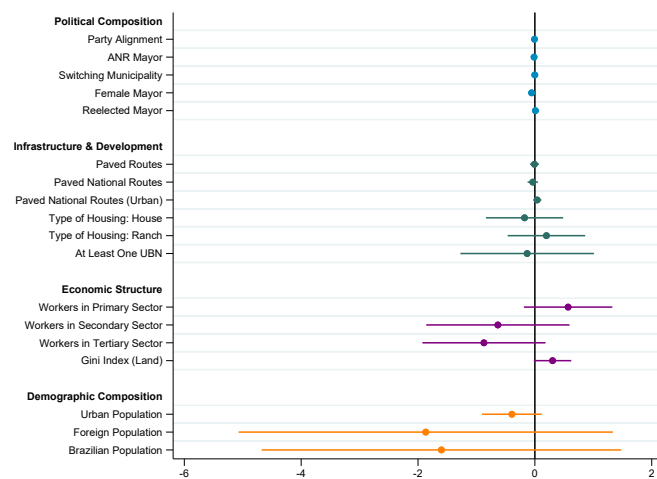
Figure 2.4: Heterogeneous Effects: Expenditure Outcomes



(a) Total Expenditure



(b) Current Expenditure



(c) Capital Expenditure

These results are consistent with the theoretical model, which defines political composition in terms of underlying voter groups (rich, middle-class, and poor) rather than the observable characteristics of elected mayors. Thus, standard political indicators may not adequately capture the variation in voter composition that drives threshold crossing in the model.

Second, some evidence of heterogeneity emerges with respect to baseline development and infrastructure conditions. Municipalities with paved routes or paved national routes (either in their urban or rural areas) tend to experience an increase of about 0.015 p.p. in tax outcomes compared to municipalities that do not have paved (national) routes. They also display significant expenditure responses to dam revenues, particularly in current expenditure of about 0.1 per additional PYG of dam revenues. In contrast, municipalities with weaker housing conditions—proxied by a higher share of households living in ranch-type dwellings—tend to exhibit negative fiscal responses in tax and expenditure outcomes, though not significantly. Similarly, municipalities with higher shares of households with at least one unsatisfied basic need exhibit negative responses, particularly for tax outcomes. Together, these results suggest that poorer municipalities with weaker baseline development and infrastructure conditions may remain in the low-spending region of the model, where public goods are less productive and transfers are more likely to crowd out local taxation. By contrast, municipalities with better baseline infrastructure and housing conditions may be closer to or above the threshold G_0 , allowing transfers to generate positive (and possibly large) fiscal responses.

Third, heterogeneity associated with local economic structure appears more pronounced. Municipalities with larger shares of workers in the secondary and tertiary sectors at baseline tend to exhibit positive tax responses to dam revenues, while municipalities with larger shares of workers in the primary sector tend to exhibit negative responses. Similarly, municipalities with larger shares of workers in the tertiary sector show positive responses in current expenditures and negative responses in capital expenditures, whereas municipalities with larger shares of workers in the primary sector exhibit the opposite trajectory. These findings suggest that complementarities between public spending and local economic activity may play an important role in shaping fiscal responses to transfers. In municipalities undergoing development, public investments financed by dam revenues may generate greater economic benefits, increasing the marginal political returns to public spending, while in municipalities with more diversified or industrialized economies, they

may potentially strengthen incentives for local tax collection. Likewise, the interaction with the land inequality index indicates that municipalities with higher land concentration tend to display positive tax and expenditure responses, although not significantly, except for capital expenditures.

Finally, demographic composition is also associated with heterogeneous fiscal responses. Municipalities with larger shares of urban, foreign, or Brazilian populations tend to show positive responses in tax outcomes. This suggests that more urbanized and economically integrated municipalities may possess greater fiscal capacity or stronger incentives to mobilize local revenues when transfers increase. These results are aligned with the theoretical model predictions. When municipalities operate in a region where public spending is more productive, additional transfers may increase the marginal political benefits of public goods, leading to higher local taxation rather than crowding out. Turning to expenditure outcomes, municipalities with larger urban, foreign, or Brazilian population shares tend to display negative responses in capital expenditure, while responses in total and current expenditure are positive, although the effects are significant only for current expenditure. One possible interpretation is that more urbanized or economically integrated municipalities already possess a relatively developed infrastructure base, reducing the need for additional capital investment financed by transfers. Instead, these municipalities may allocate additional resources toward current expenditures such as maintenance, service provision, or administrative spending. Instead, less urbanized municipalities may rely more heavily on capital spending when additional resources become available. These findings are consistent with previous results based on worker composition and suggest that demographic composition may influence not only the magnitude of fiscal responses to transfers but also the composition of spending across expenditure categories.

The Appendix presents several robustness exercises that confirm the main findings. Appendix Figures [A2.2](#) and [A2.3](#) report heterogeneous effects from the alternative specification that additionally interacts dam revenues with the baseline 2005 affected municipality indicator. The general patterns remain qualitatively similar to the baseline results, indicating that the heterogeneous responses are not driven by differential trends between affected and non-affected municipalities.

Appendix Figure [A2.4](#) decomposes the unsatisfied basic needs index into its components, including housing quality, sanitary infrastructure, access to education, and subsistence capacity. The results suggest that the negative fiscal responses observed in municipalities with higher levels of unsatisfied basic needs reflect wider socioeconomic constraints rather than a single dimension of

deprivation.

Because some demographic variables are measured as shares of the municipal population, one potential concern is that they may be mechanically related to the population-based structure underlying the shift-share instrument. However, the instrument relies on baseline population shares within affected and non-affected municipalities rather than on these demographic characteristics themselves, and municipality fixed effects absorb time-invariant demographic differences across municipalities. To test this potential concern, I residualize demographic and sectoral composition variables with respect to baseline municipality size by regressing each characteristic on the log of 2002 population and its square, and then use the residuals in the interaction specifications. This procedure removes variation mechanically related to municipality size and to the population-based structure underlying the shift-share instrument. I use the log population and its square to allow for a flexible relationship between demographic characteristics and municipality size, accommodating non-linear scaling patterns across municipalities. The resulting estimates in Appendix Figure [A2.5](#) are qualitatively similar to the baseline results, indicating that the observed heterogeneity is not driven by scale effects or by the population structure used to construct the instrument. The interaction coefficients, therefore, capture differences in fiscal responses associated with demographic composition rather than variation directly driving the instrument.

Overall, the heterogeneous effects estimates provide evidence supporting the theoretical model developed in Section [2.2](#). While political variables appear to play a limited role in explaining heterogeneity, differences in local economic structure, urbanization, foreign population, and development conditions are strongly associated with variation in fiscal responses to dam revenues. These results suggest that municipalities differ in their proximity to the minimum spending threshold and in the effectiveness of public spending above that threshold. Municipalities with stronger economic bases, greater urbanization, and a greater share of foreign population appear more likely to operate in environments where additional transfers translate into larger fiscal responses, including increases in tax collection, while municipalities with weaker development conditions remain in the low-spending region where transfers crowd out local taxation.

2.5.2 Mixed Effects

Table 2.1 reports the reduced-form mixed-effects estimates on tax (Panel A) and expenditure (Panel B) outcomes. In both panels, Columns (1)–(3) present the estimates of the baseline specification, while Columns (4)–(6) the estimates of the alternative specification that adds the interaction term $R_{idt}^P \times \text{Affected}$ to the model. Results show that the average reduced-form response to predicted dam revenues over the period 2006-2024 is positive and statistically significant for all tax and expenditure outcomes in the baseline specification. At the same time, the estimated variance of the random slope is large across outcomes, indicating dispersion in municipality-specific responses. In particular, the standard deviation of the random slope is large for total taxes and total expenditures, and remains sizable for property taxes, other taxes, current, and capital expenditures. These results imply that municipalities differ in how strongly they translate exogenous increases in dam revenues into fiscal outcomes. This aligns with the theoretical model, which predicts that municipalities may operate in different spending regimes depending on their underlying characteristics and their proximity to the threshold G_0 . The alternative specification yields similar estimates of the random-slope variance and preserves the overall distribution of municipality-specific responses. This suggests that the heterogeneity documented here is not driven solely by differences between affected and non-affected municipalities, but instead reflects broader variation in fiscal behavior among municipalities.

Figure 2.5 provides a graphical representation of this heterogeneity by plotting municipality-specific slopes for total taxes and total expenditures estimated from the baseline mixed-effects models. Each point represents a municipality's response to predicted dam revenues. The solid lines mark the average (fixed-effect) responses, and the dashed lines correspond to their 95% confidence intervals. The horizontal red lines are the average response of total taxes and their confidence intervals, while the vertical blue lines represent the average response of total expenditures and their confidence intervals. Municipalities are classified into four quadrants depending on whether their responses fall above or below the confidence bounds, distinguishing between high-response, low-response, and asymmetric-response groups, as labeled in the green boxes. The figure shows dispersion around the average responses and reveals that municipalities are distributed across all four quadrants. Some municipalities lie in the high total tax/high total expenditure quadrant, indicating that increases in dam revenues are associated with above-average responses in both

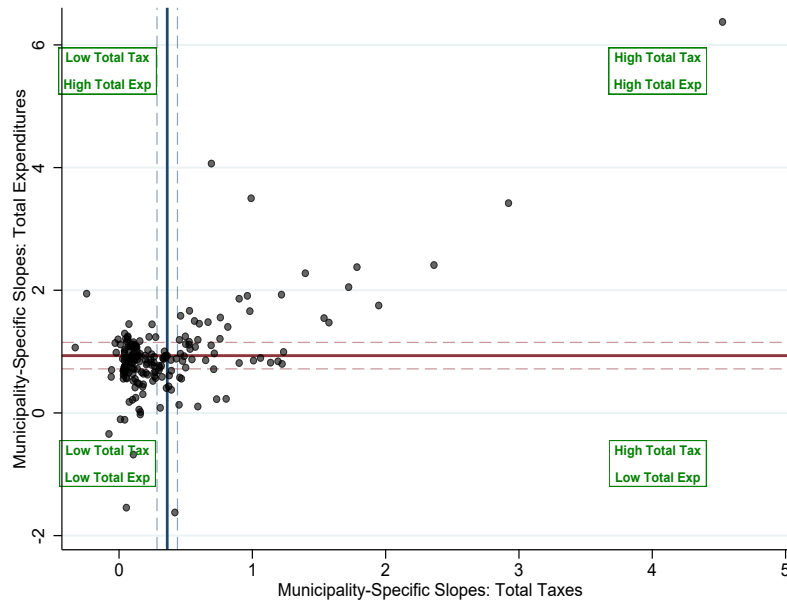
Table 2.1: Mixed-Effects Estimates

<i>Panel A. Tax Revenue Outcomes</i>						
	Total Taxes (1)	Property Taxes (2)	Other Taxes (3)	Total Taxes (4)	Property Taxes (5)	Other Taxes (6)
<i>Fixed Effects</i>						
Predicted Dam Revenues (β_{10})	0.361*** (0.039)	0.139*** (0.017)	0.205*** (0.023)	0.411*** (0.051)	0.161*** (0.023)	0.229*** (0.030)
Predicted Dam Revenues $\times$ Affected				-0.192*** (0.060)	-0.085*** (0.025)	-0.089** (0.038)
<i>Random Effects</i>						
Var(σ_{1i})	0.280	0.062	0.084	0.275	0.061	0.084
SD(σ_{1i})	0.529	0.248	0.290	0.525	0.247	0.289
Observations	2,758	2,946	2,758	2,758	2,946	2,758
<i>Panel B. Public Expenditure Outcomes</i>						
	Total Expenditure (1)	Current Expenditure (2)	Capital Expenditure (3)	Total Expenditure (4)	Current Expenditure (5)	Capital Expenditure (6)
<i>Fixed Effects</i>						
Predicted Dam Revenues (β_{10})	0.934*** (0.110)	0.465*** (0.069)	0.641*** (0.039)	1.019*** (0.169)	0.520*** (0.085)	0.691*** (0.072)
Predicted Dam Revenues $\times$ Affected				-0.230 (0.239)	-0.149 (0.125)	-0.124 (0.150)
<i>Random Effects</i>						
Var(σ_{1i})	0.551	0.351	0.061	0.549	0.351	0.060
SD(σ_{1i})	0.742	0.593	0.248	0.741	0.593	0.245
Observations	2,992	2,992	2,992	2,992	2,992	2,992

Notes: Sample consists of 200 municipalities that did not change status since 2005, excluding Asunción, the country's capital. Panel A expresses variables as shares of the previous year's total revenues. Panel B expresses variables in per capita terms using the previous year's population. All regressions include department-year FE. Sample period 2006–2024. Clustered SE by municipality are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

revenue mobilization and spending. Others lie in the low total tax/low total expenditure quadrant, suggesting below-average responses along both dimensions. The two off-diagonal quadrants capture asymmetric adjustments: municipalities that increase expenditures strongly without similar strong tax responses, and municipalities that mobilize taxes strongly without translating them into equally strong expenditure increases.

Figure 2.5: Municipality-Specific Responses: Total Taxes & Total Expenditures

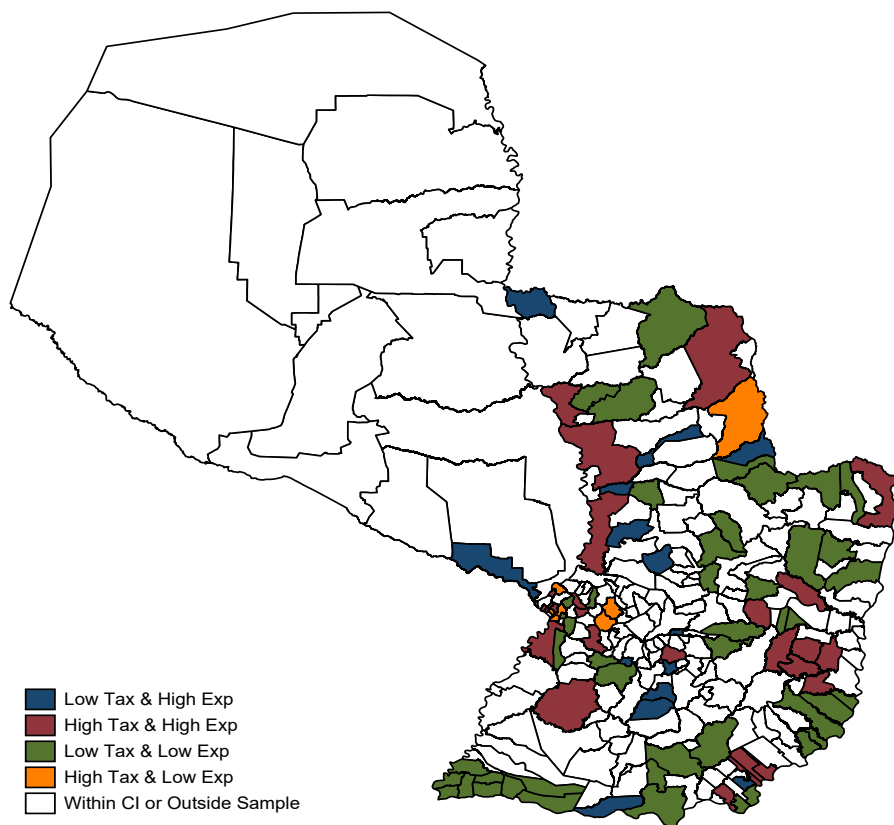


This distribution of responses closely mirrors the logic of the theoretical model. Municipalities in the low-response quadrant should belong to the low-spending region, in which transfers have relatively weak fiscal effects and may crowd out local taxation. Instead, municipalities in the high-response quadrant should operate above the threshold G_0 , where public spending becomes more productive and transfers can reinforce local revenue mobilization rather than displace it. The off-diagonal quadrants can be interpreted as intermediate or asymmetric cases, in which municipalities adjust along one fiscal margin more than the other. Appendix Figure A2.6, Panel (a), confirms that including the interaction between predicted dam revenues and affected status yields a similar distribution of municipality-specific slopes across quadrants.

To further interpret the heterogeneity observed in Figure 2.5 and assess whether it exhibits systematic spatial patterns, Figure 2.6 displays the geographical distribution of municipalities according to their quadrant classification. Municipalities that fall within the confidence intervals or

are not included in the estimation sample are not colored. The figure reveals that heterogeneous fiscal responses are not randomly distributed across space. Instead, municipalities with similar responses tend to cluster geographically.

Figure 2.6: Geographical Location of Municipalities by Quadrant



Based on this spatial clustering of fiscal responses, the next step is to examine the characteristics shared by municipalities within each quadrant. Table 2.2 shows the means of the same municipal characteristics examined above to help characterize these groups.⁴ It shows that the quadrant classification aligns closely with the interaction-based heterogeneity results presented earlier. Municipalities in the high total tax/high total expenditure quadrant tend to be more developed and economically integrated. They are more likely to have paved routes and paved national routes, exhibit higher shares of households living in houses and lower shares living in ranches, have a lower incidence of unsatisfied basic needs, and display lower employment shares in the primary sector and higher shares in the tertiary sector. They also exhibit higher shares of urban, foreign, and Brazilian

⁴See Appendix Table A2.1 for more disaggregated summary statistics by municipal characteristic.

populations. While the foreign population shares likely capture economic integration, the Brazilian population share is closely associated with agribusiness activity. This greater economic activity is accompanied by higher land inequality, though. Together, these patterns suggest more commercially oriented and externally integrated local economies, which can expand the tax base and increase the productivity of public spending. By contrast, municipalities in the low total tax/low total expenditure quadrant tend to be less developed and more rural. They display higher employment shares in the primary sector, lower shares in the tertiary sector, lower levels of urbanization, lower land inequality, weaker infrastructure, and worse indicators of housing and living conditions. These differences are in line with the interaction-effects estimates, which show positive fiscal responses in municipalities with higher urbanization, better infrastructure, and more service-oriented economic structures, and negative responses in more rural municipalities with poorer infrastructure and higher shares of workers in the primary sector.

Table 2.2: Characteristics of Municipalities by Fiscal Response Quadrant

	Low Total Taxes & High Total Expenditure	High Total Taxes & High Total Expenditure	Low Total Taxes & Low Total Expenditure	High Total Taxes & Low Total Expenditure
<i>Political Composition</i>				
Party Alignment	0.696	0.467	0.476	0.457
ANR Mayor	0.855	0.593	0.598	0.571
Switching Municipality	0.265	0.333	0.390	0.314
Female Mayor	0.073	0.059	0.079	0
Reelected Mayor	0.321	0.398	0.321	0.286
<i>Infrastructure & Development</i>				
Paved Routes	0.575	0.899	0.656	0.910
Paved National Routes	0.414	0.751	0.384	0.541
Paved National Routes (Urban)	0.399	0.630	0.310	0.541
Households in House	0.697	0.821	0.758	0.869
Households in Ranch	0.288	0.119	0.229	0.093
At Least One UBN	0.554	0.378	0.529	0.408
<i>Economic Structure</i>				
Workers in Primary Sector	0.571	0.307	0.617	0.191
Workers in Secondary Sector	0.114	0.179	0.114	0.240
Workers in Tertiary Sector	0.302	0.492	0.260	0.541
Land Inequality (Gini)	0.850	0.832	0.779	0.774
<i>Demographic Composition</i>				
Urban Population	0.342	0.575	0.278	0.713
Foreign Population	0.021	0.072	0.034	0.021
Brazilian Population	0.007	0.056	0.024	0.009
Municipalities	14	27	46	7

Notes: This table reports means by fiscal response quadrant. Political composition variables are measured for the election years 2001, 2006, 2010, 2015, and 2021. Paved routes variables are measured for the years 2001, 2009, 2011, 2012, 2014, 2017, 2019, and 2021. Household variables, urban and foreign populations are measured from the 2002 and 2022 Censuses. Households with at least one UBN are measured from the 2002, 2012 and 2022 Censuses. Workers by sector are measured from the 2002 Census. Land inequality is measured from the 2008 and 2022 Agricultural Censuses.

The two off-diagonal quadrants exhibit a mix of characteristics from both extremes. Municipal-

ities with low taxes but high expenditures tend to share some characteristics with less developed areas, such as higher primary sector employment and weaker infrastructure, but are closer to more developed municipalities in terms of certain demographic and housing indicators. Conversely, municipalities with high taxes but low expenditures tend to exhibit characteristics closer to those of more developed and economically integrated areas, including higher shares of employment in the tertiary sector and better infrastructure, but do not translate these conditions into equally strong expenditure responses. These characteristics indicate that municipalities adjust along one fiscal margin more strongly than the other.

Political variables, in turn, do not exhibit clear differences across quadrants, although some variation is present. In particular, municipalities in the low total tax/high total expenditure quadrant exhibit higher levels of party alignment and a higher prevalence of ANR mayors relative to other groups, while municipalities in the high total tax/low total expenditure quadrant tend to have lower levels of party alignment and ANR representation as well as no female mayors and smaller reelection rates. Yet these results suggest that political characteristics, as measured here, are not strongly associated with the distribution of fiscal responses. This mirrors earlier interaction results, in which most political variables display small and statistically insignificant effects. This finding does not contradict the theoretical model, as the model’s political composition is formulated in terms of differences in the composition of voter groups (rich, middle-class, and poor), whereas the empirical political variables available here are only imperfect proxies for those underlying voter-based composition.

Table 2.3 provides additional insight into how municipalities differ in the composition of their fiscal responses. Municipalities in the high total tax/high total expenditure quadrant display the highest mean levels of other taxes and current expenditure, indicating fiscal expansion. In contrast, municipalities in the low total tax/low total expenditure quadrant exhibit much lower tax revenues and current expenditures relative to the high-response quadrant, reflecting weak responses across both fiscal margins. Differences in capital expenditure follow a distinct trajectory. Municipalities in the low-response quadrant exhibit higher capital expenditure than those in the high-response quadrant, likely reflecting differences in spending composition rather than stronger fiscal responses. In particular, municipalities in the high-response quadrant appear to allocate a larger share of resources toward current expenditures, such as personnel, service provision, and maintenance, whereas

municipalities in the low-response quadrant rely relatively more on capital spending, possibly reflecting project-based investment in less developed areas.

The two asymmetric quadrants are particularly informative. Municipalities in the low total tax/high total expenditure quadrant display relatively low tax outcomes but comparatively high levels of current and capital expenditure, resembling a flypaper-type response in which transfers are translated primarily into spending rather than local revenue mobilization. By contrast, municipalities in the high total tax/low total expenditure quadrant exhibit relatively high levels of tax revenues but low levels of expenditure, indicating stronger revenue mobilization without a comparable expansion in spending. These contrasting responses highlight that heterogeneity arises not only in the magnitude of fiscal responses but also in how municipalities allocate and mobilize resources across different fiscal instruments.

Table 2.3: Composition of Taxes & Expenditures by Fiscal Response Quadrant

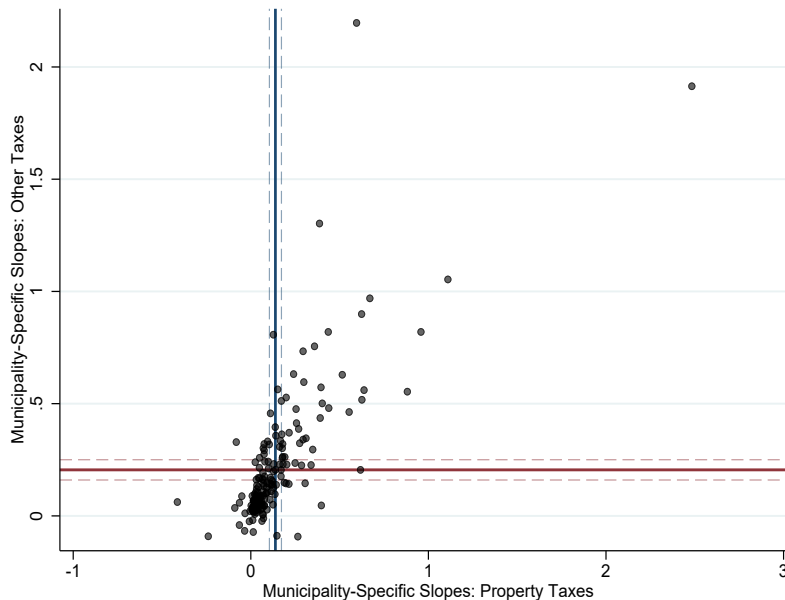
	Municipalities	Property Taxes	Other Taxes	Current Expenditure	Capital Expenditure
Low Total Taxes & High Total Expenditure	14	5.011	6.205	0.149	0.190
High Total Taxes & High Total Expenditure	27	16.865	25.373	0.182	0.090
Low Total Taxes & Low Total Expenditure	46	6.021	8.460	0.094	0.142
High Total Taxes & Low Total Expenditure	7	17.126	24.511	0.071	0.040

Notes: This table reports means by fiscal response quadrant. Tax variables are expressed as shares of the previous year's total revenues. Expenditure variables are expressed in per capita terms using the previous year's population. Sample period 2006–2024.

Figures 2.7 and 2.8 provide a decomposition of these results. Figure 2.7 plots municipality-specific slopes for property taxes and other taxes, while Figure 2.8 plots municipality-specific slopes for current and capital expenditures, all estimated from the baseline mixed-effects models. As before, each point represents a municipality's response to predicted dam revenues. The solid lines mark the average (fixed-effect) responses, and the dashed lines correspond to their 95% confidence intervals. Figure 2.7 shows that some heterogeneity in tax responses is present in both property taxes and other taxes, although the dispersion is more pronounced for other taxes. Municipalities with high tax responses tend to exhibit high responses in both components, but there is also a slight variation in the composition of tax adjustment. Figure 2.8 shows a less well-defined relationship in expenditure responses. Current expenditure displays dispersion in municipality-specific slopes, whereas capital expenditure responses are more tightly clustered around the average. This

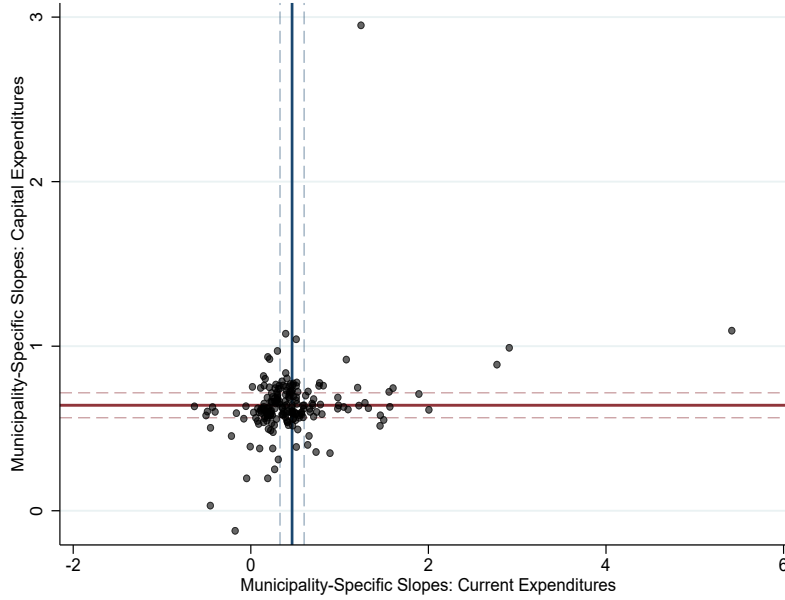
observation echoes the descriptive evidence in Table 2.3, where the most responsive municipalities tend to exhibit higher current expenditure responses. One possible interpretation is that municipalities operating above the threshold G_0 use additional transfers to expand capital investment and to maintain and operate existing infrastructure and services. The interaction-based results paint a similar picture, showing higher current expenditure responses in more urbanized and developed municipalities and smaller or even negative capital expenditure responses for those same characteristics. These general conclusions remain when adding the interaction between predicted dam revenues and affected status, as reported in the Appendix Figure A2.6, Panels (b) and (c).

Figure 2.7: Municipality-Specific Responses: Property Taxes & Other Taxes



Taken together, the mixed-effects results complement the interaction-based heterogeneity analysis in an important way. While the interaction models identify observable characteristics associated with different fiscal responses, the mixed-effects approach reveals the full distribution of responses among municipalities. Both approaches point to a consistent conclusion: municipalities that are more urbanized, better connected, more service-oriented, and with better living conditions are more likely to display amplified fiscal responses to dam revenues, whereas more rural and less developed municipalities are more likely to remain in low-response regimes. This joint evidence is closely aligned with the theoretical model, in which differences in preferences and in the productivity of public spending determine whether municipalities cross the threshold G_0 and how they respond to

Figure 2.8: Municipality-Specific Responses: Current Expenditures & Capital Expenditures



transfers once that threshold is reached.

2.6 Conclusion

This paper examines whether the effects of hydroelectric dam revenues on municipal public finance outcomes vary among municipalities in Paraguay. Building on the average effects documented in Chapter 1, the analysis shows that fiscal responses to transfers are highly heterogeneous. Municipalities differ substantially in how they translate additional dam revenues into local tax collection and public spending, implying distinct fiscal adjustments across municipalities.

To guide the empirical analysis, I develop a political economy model in which municipalities may operate under different spending regimes depending on the effectiveness of public spending and the political incentives they face. The model highlights that municipalities may remain in a low-spending regime, transition at a threshold level of spending, or operate in a high-spending regime where public goods are more productive. Conditional on the regime, the response of local taxation to transfers depends on the marginal productivity of public spending and the returns to scale of public goods, generating attenuated, regular, or amplified flypaper-type responses.

The empirical results provide support for this framework. Interaction-based estimates show that

political variables play a limited role in explaining heterogeneity, whereas baseline development, infrastructure, economic structure, and demographic composition are strongly associated with fiscal responses. Municipalities with better infrastructure, higher urbanization, and more service-sector-oriented economic structures tend to exhibit stronger positive responses to dam revenues, including increases in local taxation. In contrast, more rural and less developed municipalities exhibit weaker or even negative responses and patterns consistent with tax crowd-out. These findings suggest that local economic conditions play a central role in determining how transfers affect fiscal behavior.

The mixed-effects analysis complements these results by documenting considerable dispersion in municipality-specific responses. Municipalities are distributed across distinct response quadrants, including cases of high responses in both taxation and spending, low responses in both margins, and asymmetric adjustments across fiscal instruments. These differences are not randomly distributed, but align with observable differences in development, infrastructure, and economic integration. Municipalities with stronger economic bases and better connectivity are more likely to exhibit amplified fiscal responses, while less developed municipalities are more likely to remain in low-response quadrants.

The results imply that the impacts of intergovernmental transfers depend on the local conditions in which these resources are received. In more developed municipalities, transfers tend to reinforce both spending and revenue mobilization, in line with the higher productivity of public spending. In less developed municipalities, transfers generate weaker fiscal expansions and limited increases in taxation, suggesting that low baseline capacity constrains the impact of additional resources.

These findings have important implications for both research and policy. First, they show that focusing on average effects can obscure meaningful variation across local governments. Second, they suggest that transfer policies may have uneven impacts depending on preexisting local conditions, strengthening fiscal capacity in some municipalities while leaving others in low-response equilibria. More broadly, the results highlight the importance of complementing intergovernmental transfers with policies that improve local infrastructure, economic development, and administrative capacity in order to enhance their effectiveness.

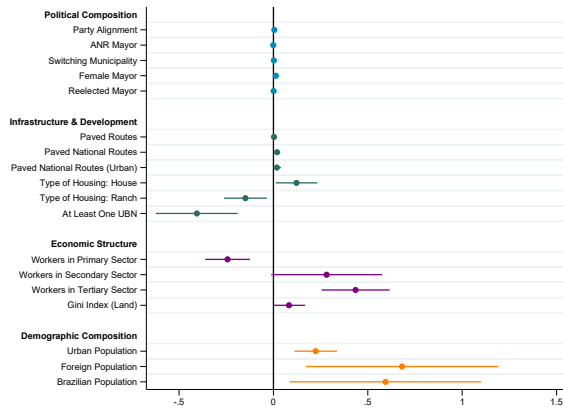
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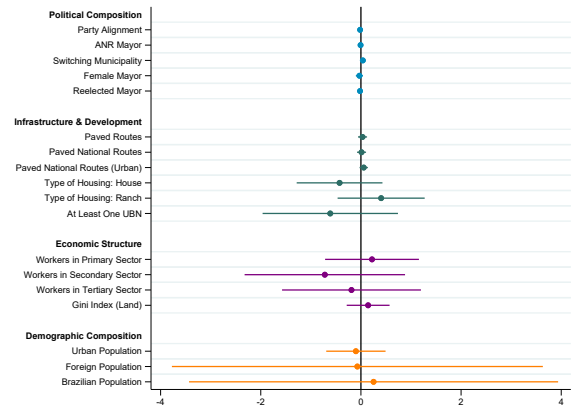
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A2 Appendix: Figures and Tables

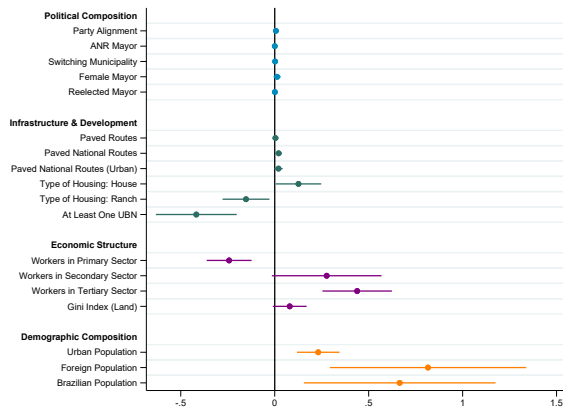
Figure A2.1: Reduced Form Heterogeneous Effects: Total Tax & Total Expenditure Outcomes



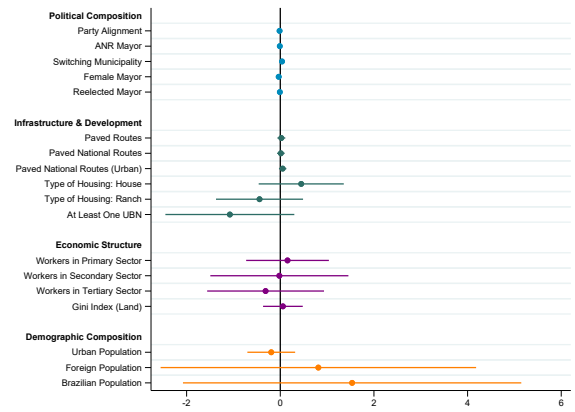
(a) Tax Outcomes



(b) Expenditure Outcomes

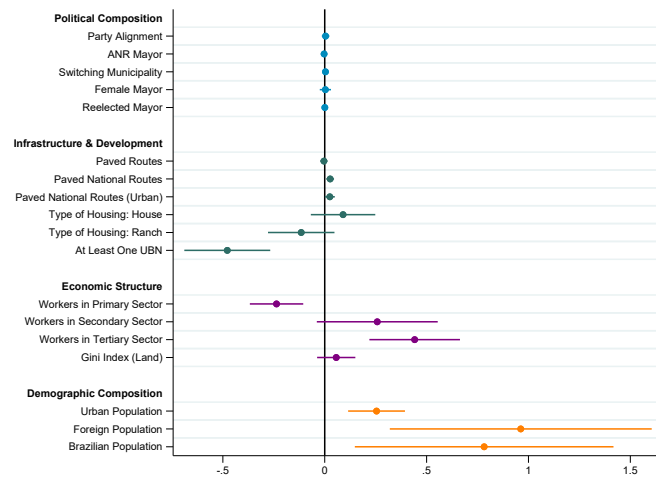


(c) Tax Outcomes (Alternative Specification)

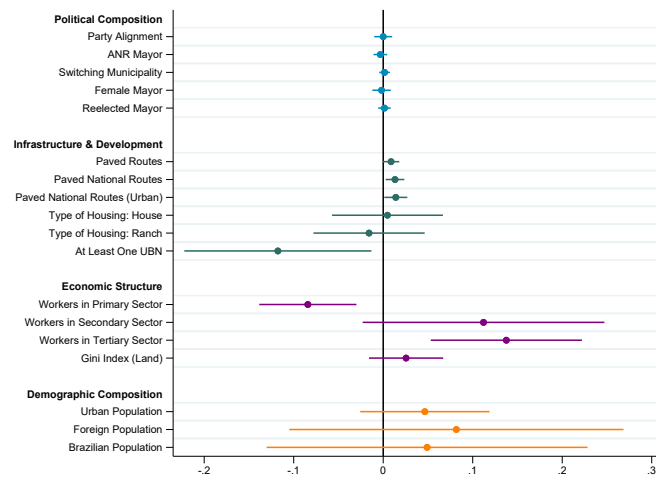


(d) Expenditure Outcomes (Alternative Specification)

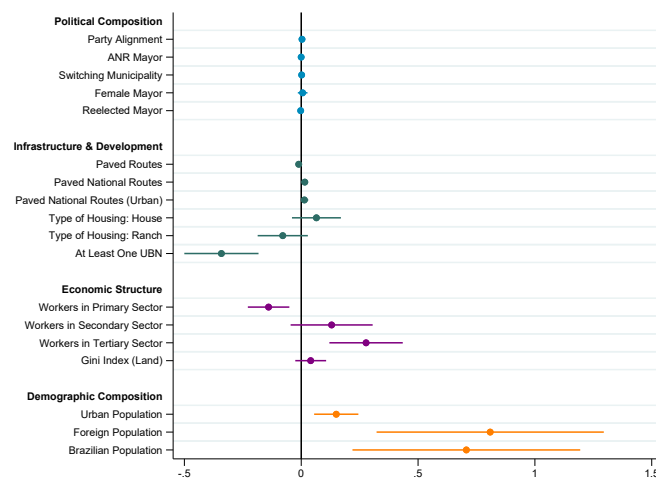
Figure A2.2: Heterogeneous Effects: Tax Outcomes (Alternative Specification)



(a) Total Taxes

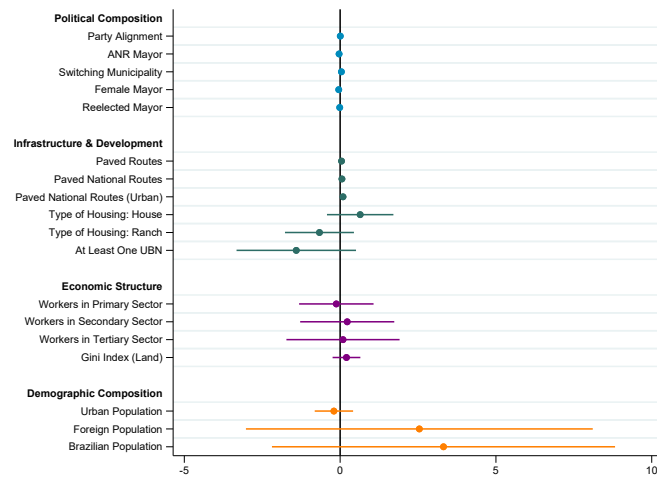


(b) Property Taxes

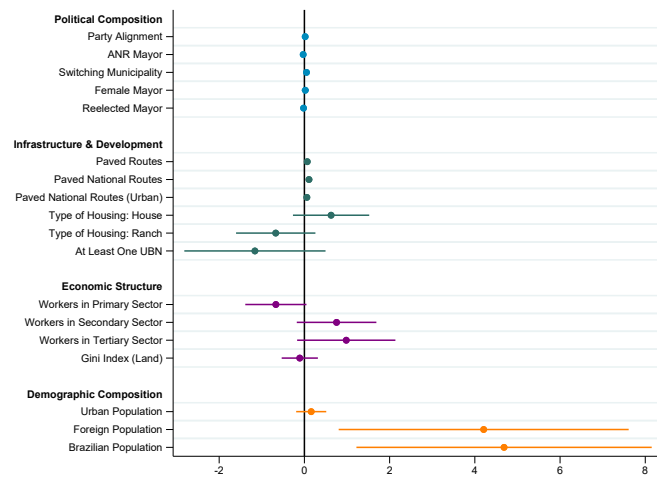


(c) Other Taxes

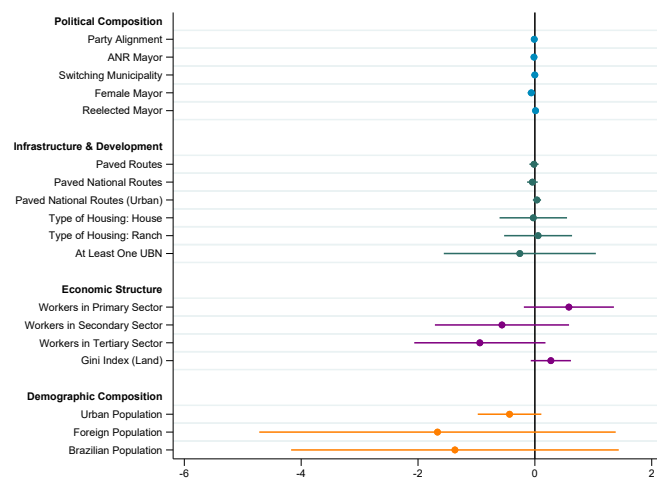
Figure A2.3: Heterogeneous Effects: Expenditure Outcomes (Alternative Specification)



(a) Total Expenditure

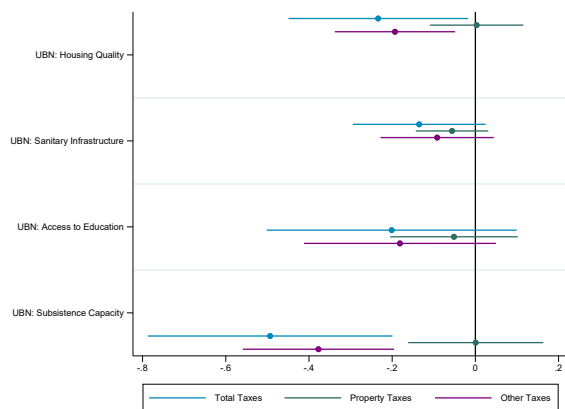


(b) Current Expenditure

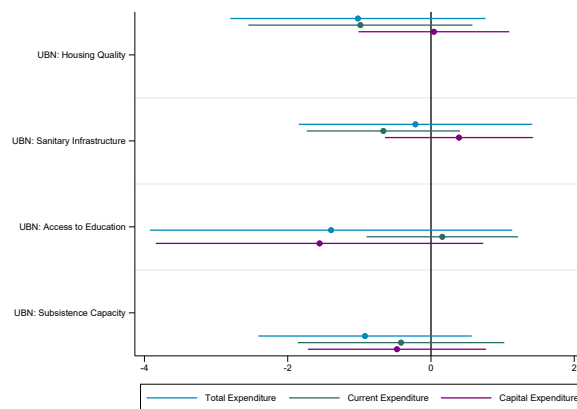


(c) Capital Expenditure

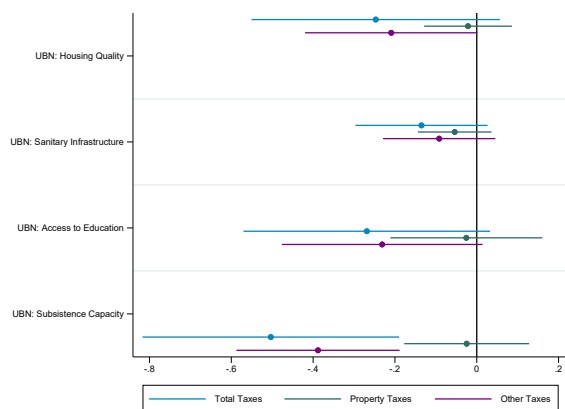
Figure A2.4: Heterogeneous Effects: Unsatisfied Basic Needs by Category



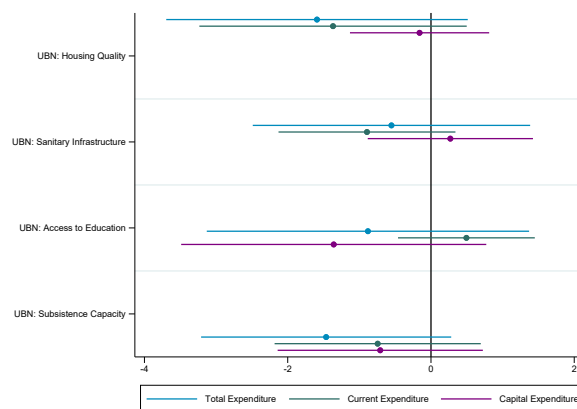
(a) Tax Outcomes



(b) Expenditure Outcomes

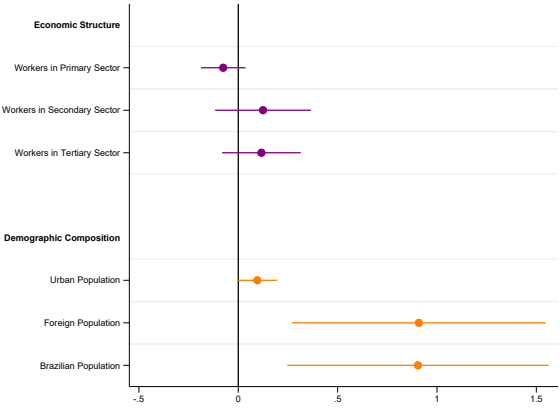


(c) Tax Outcomes (Alternative Specification)

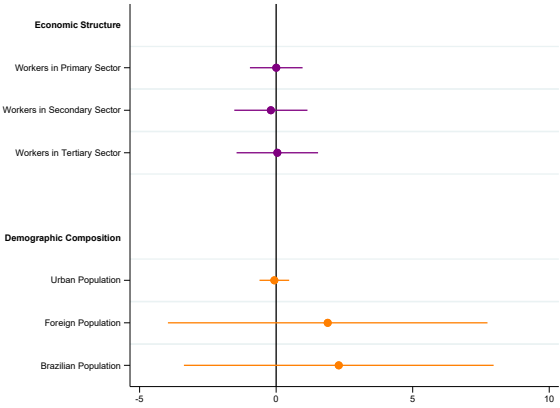


(d) Expenditure Outcomes (Alternative Specification)

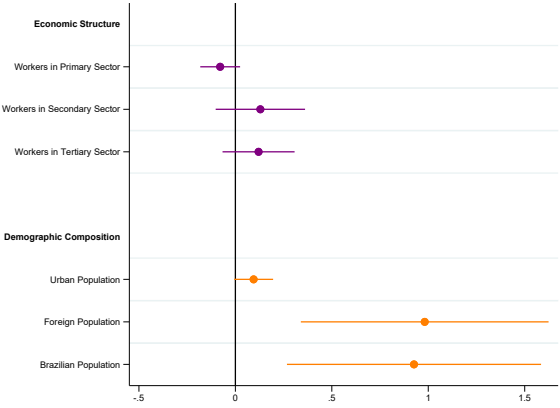
Figure A2.5: Heterogeneous Effects Based on Residualized Sectoral & Demographic Composition: Total Tax & Total Expenditure Outcomes



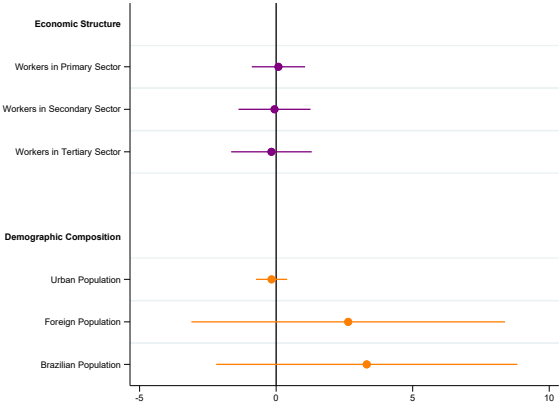
(a) Tax Outcomes



(b) Expenditure Outcomes

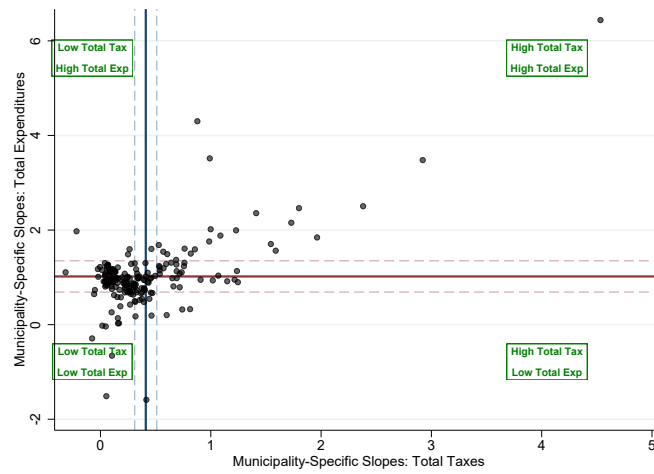


(c) Tax Outcomes (Alternative Specification)

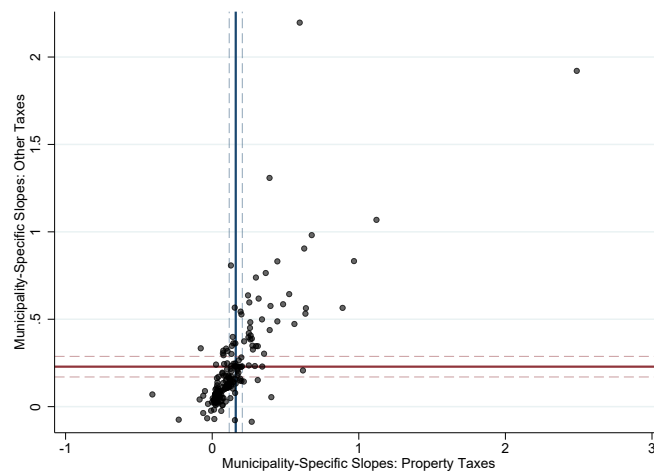


(d) Expenditure Outcomes (Alternative Specification)

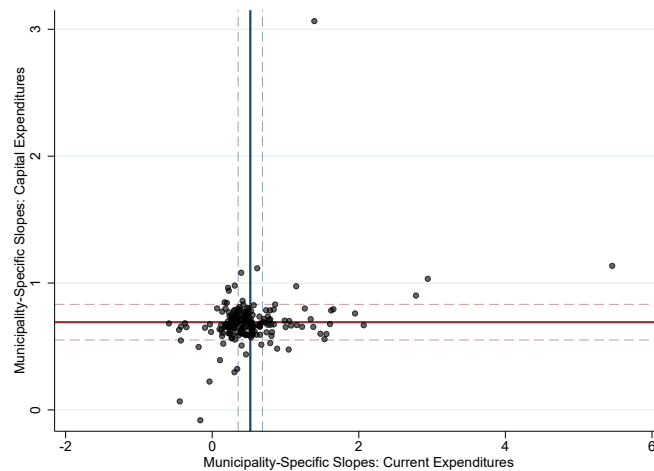
Figure A2.6: Municipality-Specific Responses: Tax & Expenditure Outcomes (Alternative Specification)



(a) Total Taxes & Total Expenditures



(b) Property Taxes & Other Taxes



(c) Current Expenditures & Capital Expenditures

Table A2.1: Summary Statistics by Fiscal Response Quadrant

	Low Total Taxes & High Total Expenditure			High Total Taxes & High Total Expenditure			Low Total Taxes & Low Total Expenditure			High Total Taxes & Low Total Expenditure		
	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max	Mean	Min	Max
<i>Political Composition</i>												
Party Alignment	0.696 [0.464]	0	1	0.467 [0.501]	0	1	0.476 [0.501]	0	1	0.457 [0.505]	0	1
ANR Mayor	0.855 [0.355]	0	1	0.593 [0.493]	0	1	0.598 [0.491]	0	1	0.571 [0.502]	0	1
Switching Municipality	0.265 [0.445]	0	1	0.333 [0.473]	0	1	0.390 [0.489]	0	1	0.314 [0.471]	0	1
Female Mayor	0.073 [0.261]	0	1	0.059 [0.237]	0	1	0.079 [0.270]	0	1	0 [0]	0	0
Reelected Mayor	0.321 [0.471]	0	1	0.398 [0.492]	0	1	0.321 [0.468]	0	1	0.286 [0.460]	0	1
<i>Infrastructure & Development</i>												
Paved Routes	0.575 [0.495]	0	1	0.899 [0.302]	0	1	0.656 [0.475]	0	1	0.910 [0.288]	0	1
Paved National Routes	0.414 [0.493]	0	1	0.751 [0.433]	0	1	0.384 [0.487]	0	1	0.541 [0.500]	0	1
Paved National Routes (Urban)	0.399 [0.491]	0	1	0.630 [0.483]	0	1	0.310 [0.463]	0	1	0.541 [0.500]	0	1
Households in House	0.697 [0.168]	0.342	0.914	0.821 [0.091]	0.450	0.954	0.758 [0.151]	0.298	0.953	0.869 [0.061]	0.686	0.923
Households in Ranch	0.288 [0.178]	0.036	0.657	0.119 [0.108]	0.007	0.536	0.229 [0.154]	0.033	0.683	0.093 [0.070]	0.015	0.290
At Least One UBN	0.554 [0.182]	0.252	0.943	0.378 [0.146]	0.141	0.705	0.529 [0.152]	0.236	0.812	0.408 [0.155]	0.187	0.770
<i>Economic Structure</i>												
Workers in Primary Sector	0.571 [0.213]	0.183	0.843	0.307 [0.236]	0.007	0.808	0.617 [0.178]	0.078	0.840	0.191 [0.205]	0.016	0.554
Workers in Secondary Sector	0.114 [0.092]	0.020	0.392	0.179 [0.062]	0.053	0.282	0.114 [0.061]	0.034	0.293	0.240 [0.063]	0.139	0.318
Workers in Tertiary Sector	0.302 [0.148]	0.128	0.570	0.492 [0.176]	0.138	0.746	0.260 [0.119]	0.114	0.616	0.541 [0.136]	0.291	0.673
Land Inequality (Gini)	0.850 [0.079]	0.617	0.950	0.832 [0.089]	0.673	0.971	0.779 [0.100]	0.402	0.932	0.774 [0.042]	0.745	0.822
<i>Demographic Composition</i>												
Urban Population	0.342 [0.218]	0.072	0.859	0.575 [0.281]	0.057	1	0.278 [0.200]	0.019	1	0.713 [0.306]	0.235	1
Foreign Population	0.021 [0.020]	0.002	0.098	0.072 [0.095]	0.003	0.381	0.034 [0.046]	0.003	0.268	0.021 [0.019]	0.008	0.082
Brazilian Population	0.007 [0.021]	0.0003	0.097	0.056 [0.099]	0.0003	0.373	0.024 [0.052]	0.0002	0.264	0.009 [0.022]	0.0003	0.080
Municipalities	14			27			46			7		

Notes: Political composition variables are measured for the election years 2001, 2006, 2010, 2015, and 2021. Paved routes variables are measured for the years 2001, 2009, 2011, 2012, 2014, 2017, 2019, and 2021. Household variables, urban and foreign populations are measured from the 2002 and 2022 Censuses. Households with at least one UBN are measured from the 2002, 2012 and 2022 Censuses. Workers by sector are measured from the 2002 Census. Land inequality is measured from the 2008 and 2022 Agricultural Censuses. Standard deviations are in [].

B2 Appendix: Proofs of Theoretical Model

Proposition 1: Preferences and Threshold Crossing. *Consider an incumbent who remains in the low-spending region with $G_A < G_0$. Suppose that middle-class voters place greater marginal political weight on public goods provision than the rich in the sense that the electoral responsiveness-weighted marginal utility gain from public goods is larger for the middle class than for the rich, $\frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B} \geq \frac{dI_r}{d\Delta U_r} \cdot \frac{d\Delta U_r}{dC_r} \cdot \frac{dC_r}{dY_r} \cdot \frac{\partial Y_r}{\partial P_B}$. Define the marginal political weight of middle-class voters on public goods as $\omega_m \equiv \frac{dI_m}{d\Delta U_m} \cdot \frac{d\Delta U_m}{dC_m} \cdot \frac{dC_m}{dY_m} \cdot \frac{\partial Y_m}{\partial P_B}$. Then, there exists a critical distance to the threshold $\bar{\Delta}(\omega_m)$ such that the opponent finds it electorally optimal to cross the threshold G_0 . Moreover, $\bar{\Delta}(\omega_m)$ is weakly increasing in ω_m , $\frac{d\bar{\Delta}(\omega_m)}{d\omega_m} \geq 0$. Hence, when middle-class voters value public goods more at the margin, the opponent can cross the threshold from farther below G_0 , making threshold crossing more likely all else equal.*

Proof. Crossing the threshold G_0 yields a discrete gain in public goods that requires raising taxes enough to reach G_0 . Other things equal, increasing the middle class's marginal political weight on public goods raises the electoral benefit from the discrete jump at G_0 , while the fiscal cost is unchanged. Therefore, the opponent's relative electoral outcome from crossing compared to remaining below G_0 shifts upward. It follows that the set of distances for which crossing is optimal expands. Defining $\bar{\Delta}(\omega_m)$ as the largest distance at which the opponent weakly prefers to cross, $\bar{\Delta}(\omega_m)$ is weakly increasing in ω_m , establishing the claim. $\square$

Proposition 2: Political Composition and Threshold Crossing. *Let $\tilde{\delta} \equiv \frac{\delta_m}{\delta_m + \delta_r} \in [0, 1]$ denote the share of middle-class voters among informed voters, holding the total informed share $\delta_I \equiv \delta_r + \delta_m$ fixed. Consider an incumbent who remains in the low-spending region with $G_A < G_0$. Suppose that the opponent's relative electoral outcome from crossing the threshold G_0 compared to remaining below it is weakly increasing in $\tilde{\delta}$. Then, there exists a critical distance to the threshold $\bar{\Delta}(\tilde{\delta})$ such that the opponent finds it electorally optimal to cross it. Moreover, $\bar{\Delta}(\tilde{\delta})$ is weakly increasing in $\tilde{\delta}$, $\frac{d\bar{\Delta}(\tilde{\delta})}{d\tilde{\delta}} \geq 0$. Hence, municipalities with a larger middle-class share among informed voters allow the opponent to cross the threshold from farther below G_0 . Equivalently, other things equal, a higher middle-class share among informed voters makes it more likely that the opponent crosses the threshold, while municipalities with a lower middle-class share are more likely to remain*

in the low-spending region.

Proof. Define $\bar{\Delta}(\tilde{\delta})$ as the critical distance at which the opponent weakly prefers to cross the spending threshold. Then, holding the total informed share δ_I fixed, an increase in the middle-class share $\tilde{\delta}$ raises the electoral return to public goods provision, given that middle-class voters place more weight on public goods than the rich, as shown in Proposition 1. As a result, the set of distances for which crossing is optimal expands, implying that $\bar{\Delta}(\tilde{\delta})$ is weakly increasing in $\tilde{\delta}$, $\frac{d\bar{\Delta}(\tilde{\delta})}{d\tilde{\delta}} \geq 0$. $\square$

Proposition 3: Heterogeneous Responses to Intergovernmental Transfers. *Suppose the opponent's optimal policy admits an interior solution within a given spending region. Then, the effect of intergovernmental transfers R on the opponent's optimal tax choice depends on the marginal productivity and shape of the public goods technology in the relevant region. (i) If the opponent remains in the low-spending region ($G_B < G_0$), where public goods are produced under diminishing returns, intergovernmental transfers weakly crowd out local tax collection, $\frac{\partial T_B^*}{\partial R} \leq 0$. (ii) If the opponent operates in the high-spending region ($G_B > G_0$), then the effect of transfers on the opponent's optimal tax choice depends on how the marginal political benefit of public goods varies with R in that region. Under diminishing returns, transfers weakly crowd out taxes, $\frac{\partial T_B^*}{\partial R} \leq 0$. In contrast, transfers can crowd in taxes, $\frac{\partial T_B^*}{\partial R} > 0$, either (a) under increasing returns above G_0 due to complementarities or network effects, or (b) even under diminishing returns if the marginal political benefit of public goods is locally increasing just above G_0 (i.e., because $f'_2(G_B)$ is sufficiently steep near G_0).*

Proof. Within each region, the opponent's optimal tax choice satisfies a first-order condition equating the marginal political benefit of public goods to the marginal political cost of taxation. Intergovernmental transfers relax the budget constraint, shifting the marginal benefit term through their effect on public spending.

Conditional on the opponent remaining below the threshold ($G_B < G_0$), redefine the first-order condition in the low-spending region as

$$F_1 = A_{G,1} \cdot M'(T_B^*) + B_T = 0$$

where

$$A_{G,1} = A_{G,1}^{\inf} + A_{G,1}^{\text{uninf}}$$

$$B_T = B_T^{\inf} + B_T^{\text{uninf}}$$

Then,

$$\frac{\partial T_B^*}{\partial R} = -\frac{\frac{\partial F_1}{\partial R}}{\frac{\partial F_1}{\partial T_B}} = -\frac{\frac{\partial A_{G,1}}{\partial R} \cdot M'(T_B^*)}{A_{G,1} \cdot M''(T_B^*) + A'_{G,1} \cdot M'(T_B^*) + B'_T}$$

In the low-spending region, the public goods technology exhibits diminishing returns— $\frac{\partial Y_j}{\partial P_B} > 0$, $\frac{\partial^2 Y_j}{\partial P_B^2} < 0$, $f'_1(G_B) > 0$ and $f''_1(G_B) < 0$. Under these assumptions, additional transfers tend to lower the marginal political benefit of public goods, implying $\frac{\partial A_{G,1}}{\partial R} \leq 0$. In this case, since $M'(T_B^*) > 0$, $A_{G,1} > 0$, $B_T < 0$, $B'_T < 0$, and assuming diminishing returns to tax collection $M''(T_B^*) < 0$ and $|A_{G,1} \cdot M''(T_B^*) + B'_T| > |A'_{G,1} \cdot M'(T_B^*)|$,

$$\frac{\partial T_B^*}{\partial R} = -\frac{\frac{\partial F_1}{\partial R}}{\frac{\partial F_1}{\partial T_B}} \leq 0$$

So in the low-spending region with diminishing returns, intergovernmental transfers weakly reduce (or leave unchanged) the optimal level of tax collection.

If, instead, the opponent's optimal tax choice belongs to the high-spending region ($G_B > G_0$), the first-order condition can be redefined similarly

$$F_2 = A_{G,2} \cdot M'(T_B^*) + B_T = 0$$

where

$$A_{G,2} = A_{G,2}^{\inf} + A_{G,2}^{\text{uninf}}$$

Then,

$$\frac{\partial T_B^*}{\partial R} = -\frac{\frac{\partial F_2}{\partial R}}{\frac{\partial F_2}{\partial T_B}} = -\frac{\frac{\partial A_{G,2}}{\partial R} \cdot M'(T_B^*)}{A_{G,2} \cdot M''(T_B^*) + A'_{G,2} \cdot M'(T_B^*) + B'_T}$$

where $\frac{\partial A_{G,2}}{\partial R}$ and $A'_{G,2}$ are defined analogously to the low-spending case, replacing $f'_1(G_B)$ with $f'_2(G_B)$ and $f''_1(G_B)$ with $f''_2(G_B)$.

The signs of both $\frac{\partial A_{G,2}}{\partial R}$ and $A'_{G,2}$ are a priori ambiguous because they depend on the direction of (i) the effect of public spending on public goods, and (ii) the effect of public goods on voter

income.

Under diminishing returns assumptions—concave region with $\frac{\partial Y_j}{\partial P_B} > 0$, $\frac{\partial^2 Y_j}{\partial P_B^2} < 0$, $f'_2(G_B) > 0$ and $f''_2(G_B) < 0$ —additional transfers tend to lower the marginal political benefit of public spending, implying $\frac{\partial A_{G,2}}{\partial R} \leq 0$. In this case, since $M'(T_B^*) > 0$, $A_{G,2} > 0$, $B_T < 0$, $B'_T < 0$, $M''(T_B^*) < 0$ and $|A_{G,2} \cdot M''(T_B^*) + B'_T| > |A'_{G,2} \cdot M'(T_B^*)|$,

$$\frac{\partial T_B^*}{\partial R} = -\frac{\frac{\partial F_2}{\partial R}}{\frac{\partial F_2}{\partial T_B}} \leq 0$$

So intergovernmental transfers weakly reduce (or leave unchanged) the optimal level of tax collection as in the low-spending region.

In a convex region—where complementarities and network externalities generate increasing returns to public goods $\frac{\partial Y_j}{\partial P_B} > 0$, $\frac{\partial^2 Y_j}{\partial P_B^2} > 0$, $f'_2(G_B) > 0$ and $f''_2(G_B) > 0$ —additional transfers raise the marginal political benefit of public goods, yielding $\frac{\partial A_{G,2}}{\partial R} > 0$. Then, additional transfers increase tax collection as follows

$$\frac{\partial T_B^*}{\partial R} = -\frac{\frac{\partial F_2}{\partial R}}{\frac{\partial F_2}{\partial T_B}} > 0$$

Importantly, $\frac{\partial T_B^*}{\partial R} > 0$ does not require $f''_2(G_B) > 0$ to be convex globally. It is sufficient that the marginal political benefit of public goods $A_{G,2}$ increases with R over the relevant range just above the threshold G_0 . This can occur even when $f_2(G_B)$ is concave ($f''_2(G_B) < 0$) if the marginal productivity $f'_2(G_B)$ is sufficiently high just above G_0 , so that the marginal political benefit of public goods increases over the relevant range. In such cases, additional transfers increase the payoff to pushing spending into the high-spending region, implying $\frac{\partial A_{G,2}}{\partial R} > 0$ and thus $\frac{\partial T_B^*}{\partial R} > 0$. Consequently, whether intergovernmental transfers crowd out or crowd in taxes depends crucially on the technological regime of public goods production. $\square$

Chapter 3

Arts-Based Pedagogical Innovation and Student Outcomes: Experimental Evidence from Paraguay

Co-authored with Claudio Cappello and José Molinas Vega

3.1 Introduction

Improving learning outcomes in low- and middle-income countries remains one of the central challenges in education policy. Over the past decades, substantial progress has been achieved in expanding school enrollment and access to formal education. However, improvements in school participation have not necessarily translated into significant gains in learning quality ([World Bank et al. 2022](#)). A growing body of evidence shows that many students complete primary school without reaching minimum proficiency levels in reading and mathematics, even after several years of formal schooling ([UNESCO 2021](#)). These concerns have generated growing interest in pedagogical interventions that seek not only to improve academic achievement directly, but also to strengthen the socioemotional and motivational dimensions associated with learning engagement, classroom participation, and persistence ([Cunha, Heckman, and Schennach 2010](#); [Heckman and Kautz 2013](#); [Berger et al. 2025](#)).

Within this broader debate, arts-based and active learning pedagogical methodologies have

gained increasing prominence. These approaches aim to replace passive forms of instruction based on memorization with participatory learning environments that encourage creativity, interpretation, collaboration, and critical thinking. While active learning methodologies emphasize students' participation and engagement in constructing knowledge, arts-based methodologies—which can be considered a type of active learning—integrate artistic expression into teaching and learning activities (Bonwell and Eison 1991; Freeman et al. 2014; Møller-Skau and Lindstøl 2022). Although qualitative literature highlights the potential benefits of these methodologies for student engagement and socioemotional development (Sommer 2014; Cultural Agents Initiative 2026), rigorous causal evidence on their effectiveness remains relatively scarce.

This paper evaluates the effects of the Pre-Texts methodology, an arts-based literacy and active learning intervention, on socioemotional and academic outcomes. The methodology combines reading, artistic production, collective discussion, and creative interpretation of texts to promote student engagement with learning activities (Cultural Agents Initiative 2026). While Pre-Texts has been implemented in more than 50 countries, little is known about whether this pedagogical approach influences students' socioemotional development, reading engagement, and academic performance in primary education settings. Given its emphasis on reading, interpretation, and collaborative engagement with texts, the methodology is expected to affect language-related and motivational outcomes, but improvement in academic outcomes may also emerge through changes in classroom engagement and learning processes.

We study this question in the context of Paraguay, where persistent learning deficits make the evaluation of pedagogical innovations particularly relevant. Despite near universal access to basic schooling, national and international assessments consistently document that a majority of Paraguayan students fail to achieve minimum proficiency levels in core subjects such as reading and mathematics (Ministerio de Educación y Ciencias 2020; UNESCO 2022; OECD 2023). These educational challenges coexist with inequalities in socioeconomic conditions and school resources, raising concerns on academic achievement, students' motivation, engagement, and relationship with learning processes. In this setting, interventions that aim to strengthen reading engagement and classroom participation may offer a complementary strategy for improving educational experiences in under-resourced public schools.

To evaluate the effects of the methodology, we use data from a randomized controlled trial

implemented in collaboration with the Paraguayan Ministry of Education and Science and the local partner Instituto Desarrollo during the 2024 academic year. The study covers 150 public schools located in Asunción, the country’s capital, and the Central Department. Schools were randomly assigned to one of two treatment arms or to a control group. This paper focuses on one of the treatment arms, which consists of teacher training and classroom implementation of the Pre-Texts methodology with sixth-grade students. We combine student subject grades and repetition rates from the Ministry of Education and Science with original survey data collected at the end of the academic year to measure socioemotional outcomes related to emotional well-being, attention and effort, reading enjoyment, and reading motivation.

Our empirical strategy follows an intention-to-treat framework exploiting random assignment at the school level. In addition to estimating average treatment effects, we examine heterogeneous treatment effects across gender and school-shift categories corresponding to students attending school in the morning, afternoon, or on a double shift. We also explore whether outcomes differ according to implementation intensity, measured by the number of Pre-Texts sessions delivered in the classroom. Sessions varied widely across schools and teachers but were not randomly assigned, possibly reflecting unobserved differences across teachers or schools. As a result, these analyses provide complementary descriptive evidence on the relationship between exposure to the methodology and student outcomes and should not be interpreted as causal effects of implementation intensity.

Results indicate moderate but suggestive effects concentrated primarily in reading-related dimensions. On average, the intervention increases reading enjoyment and reading motivation, although most estimates are imprecisely estimated and not statistically distinguishable from zero at conventional levels. We also find evidence of positive effects on academic achievement in Spanish, measured as the probability of achieving the highest score, particularly when baseline academic achievement is included as a control, while effects on Mathematics and grade repetition are limited.

The heterogeneous effect analysis suggests that treatment impacts vary modestly across student groups. In particular, reading outcomes tend to exhibit somewhat larger positive effects among boys and students attending morning-shift schools, while estimated effects for other subgroups are generally smaller and not statistically significant. Overall, the heterogeneity results reinforce the pattern that the intervention appears to influence dimensions associated with reading engagement more consistently than other socioemotional outcomes.

Exploratory analyses of implementation intensity further suggest that greater exposure to the methodology is associated with greater reading motivation and engagement. By contrast, we find little evidence of improvements in other emotional well-being indicators in the short run.

This paper contributes to the growing body of experimental evidence on active learning and arts-based educational interventions. While qualitative studies have long emphasized the pedagogical potential of methodologies that integrate creativity, reading, and collaborative learning (Sommer 2014), rigorous experimental evaluations remain scarce. Two studies close to ours are Osborn et al. 2023 and Calero et al. 2017. Osborn et al. 2023 evaluate Pre-Texts with Kenyan adolescents and find reductions in depression and anxiety symptoms, while Calero et al. 2017 evaluate an arts- and theater-based youth training program in Brazil, finding positive employment and earnings impacts but limited effects on socioemotional skills. We add to this literature by providing causal evidence of an arts-based pedagogical intervention in primary education.

The paper also contributes to the economics of education literature on socioemotional skills and noncognitive development. A large literature documents the importance of socioemotional competencies such as motivation, perseverance, and self-regulation for educational attainment and long-run labor market outcomes (Heckman, Stixrud, and Urzua 2006; Cunha, Heckman, and Schen- nach 2010; Heckman and Kautz 2013; Deming 2017). More recent work examines whether these skills can be improved through educational interventions, with mixed evidence across contexts (Paunesku et al. 2015; Yeager, Hanselman, Walton, et al. 2019; Ganimian 2020). This study provides new evidence by evaluating whether a pedagogical methodology centered on reading and creative participation can influence socioemotional dimensions among primary school students.

Finally, this paper contributes to the evidence base on educational interventions in Latin America. Even though the region has experienced important progress in rigorous impact evaluation (Ganimian and Murnane 2016; Glewwe and Muralidharan 2016; Stone et al. 2020), relatively little experimental evidence exists on pedagogical innovations designed to jointly affect socioemotional and academic outcomes. By providing causal evidence of the implementation of the Pre-Texts methodology in Paraguay, this study contributes to current policy discussions on how to improve learning quality and student engagement in under-resourced public school systems.

The remainder of the paper is organized as follows. Section 3.2 describes the Paraguayan educational context. The Pre-Texts methodology is introduced in Section 3.3. Section 3.4 presents

the research design and implementation timeline. Section 3.5 describes the data and outcome construction. Section 3.6 outlines the empirical strategy, while Section 3.7 presents the main results. Section 3.8 concludes.

3.2 Education in Paraguay

Paraguay is an upper-middle-income country in South America whose education system presents a persistent and well-documented paradox: despite constitutionally guaranteed rights to free and bilingual¹ schooling, the majority of students fail to achieve minimum learning standards at every measured grade level (Ministerio de Educación y Ciencias 2020; CES 2022; UNESCO 2022; OECD 2023). The 1992 Constitution and the General Law of Education of 1998 established twelve years of compulsory schooling—nine years of Basic School Education (EEB, Educación Escolar Básica) and three years of High School Education (EM, Educación Media)—governed by a centralized Ministry of Education and Science (MEC, Ministerio de Educación y Ciencias) (Poder Legislativo 1992; Poder Legislativo 1998; Ministerio de Educación y Ciencias 2022).

The most comprehensive national evidence on learning comes from the National System for the Evaluation of the Educational Process (SNEPE, Sistema Nacional de Evaluación del Proceso Educativo), a census-based assessment administered by the MEC at the close of each educational cycle (3rd, 6th, 9th, and 12th grades). The last SNEPE was conducted in 2018 and was applied to 364,000 students across 8,100 institutions, evaluating Mathematics, Spanish communication, and Guaraní communication (Ministerio de Educación y Ciencias 2020). Across all grades and subjects, average student performance remained below the threshold defined by the MEC as the minimum satisfactory level of achievement (Agencia IP 2020). Among sixth-grade students, 76% failed to reach the minimum expected level in Mathematics, 67% in Spanish, and 77% in Guaraní (Trece 2020). Grade repetition also emerged as one of the strongest negative correlates of academic achievement across subjects and educational cycles (Ministerio de Educación y Ciencias 2020).

Regional evidence from the 2019 Regional Comparative and Explanatory Study (ERCE, Estudio Regional Comparativo y Explicativo), conducted by the United Nations Educational, Scientific and Cultural Organization (UNESCO), and administered to third- and sixth-grade students in sixteen

¹The 1992 Constitution declares Spanish and Guaraní as the country’s official languages (Poder Legislativo 1992).

Latin American countries, confirms and deepens the national picture. Paraguay’s scores placed it below the regional average in every subject at every grade level, with performance more comparable to Central American systems than to more developed South American education systems (UNESCO 2022; FEEI 2022). At sixth grade, only 5.6% of Paraguayan students attained the minimum proficiency level in Mathematics, 19% did so in Reading, and 9% in Science (UNESCO 2022). Critically, no statistically significant improvement was observed between the 2013 and 2019 rounds at the sixth grade level in Mathematics or Science, indicating that learning deficits are actively consolidated within the schooling process rather than remedied by it (FEEI 2022). These results point to persistent learning deficits that are not fully corrected during the schooling process.

3.3 The Pre-Texts Methodology

In response to these learning challenges, increasing attention has been devoted to pedagogical approaches that seek to strengthen students’ engagement in reading and classroom participation. The intervention evaluated in this study is the Pre-Texts methodology, an arts-based, active learning approach. This section describes its main components and pedagogical foundations.

Pre-Texts is an active learning methodology developed by Professor Doris Sommer as part of the Cultural Agents Initiative at Harvard University. The methodology promotes literacy, critical thinking, and socioemotional development by integrating artistic expression into classroom activities. Its central premise is that any text can serve as a starting point for interpretation, discussion, and creative production, and can be adapted to diverse educational contexts (Sommer 2014; Instituto Desarrollo 2025; Cultural Agents Initiative 2026).

The methodology aims to replace passive learning—where teachers transmit knowledge and students memorize content—with a participatory process in which students actively construct knowledge. It is organized around four main pillars. First, critical and conversational reading encourages students to interpret texts, pose questions, and engage in collective reflection. Second, reflective and creative writing invites students to produce essays, letters, and creative pieces that deepen engagement with the material. Third, artistic production incorporates theater, music, and visual arts as alternative modes of expression. Finally, active and collective participation promotes a co-operative classroom environment in which students take a leading role while teachers act primarily

as facilitators ([Instituto Desarrollo 2025](#)).

Although Pre-Texts incorporates artistic and collaborative dimensions, reading engagement remains central to the methodology. Classroom activities are designed to transform reading into an interactive and creative experience, potentially strengthening students' motivation toward texts, participation in classroom activities, and willingness to engage with academic material. Through these mechanisms, the intervention may affect both reading-related socioemotional dimensions and, over time, academic outcomes connected to language and literacy. In this study, we focus particularly on the methodology's potential to influence socioemotional dimensions of reading engagement, motivation, attention, and emotional well-being, as measured by the indices described in [Section 3.5](#), and some academic outcomes as described also in [Section 3.5](#).

3.4 Research Design and Timeline

This paper uses data from a randomized controlled trial (RCT) designed and implemented by the local partner Instituto Desarrollo in collaboration with the MEC. While the experiment included two treatment arms and one control group, this paper focuses on the effects of one intervention: the classroom implementation of the Pre-Texts methodology.²

The present study was conducted to sixth-grade students enrolled in public schools in the capital of the country, Asunción, and nine districts of the Central Department. These districts were selected in common agreement with the MEC, who initially provided a shortlist of eligible schools. Eligible schools met the following conditions: (i) urban public schools, (ii) basic education until sixth grade, (iii) regular basic education (specialized education for indigenous children and children with special needs were excluded), (iv) at least 10 students per sixth-grade section (some schools had more than one section per grade), and (v) have not implemented other educational programs that might have interfered with our study. The final study sample consisted of 150 schools.

We implemented a stratified cluster randomization to assign 50 schools to each treatment arm and 50 schools to the control group. Randomization was stratified by district, school size based on 2022 enrollment, and a baseline socioeconomic index constructed using administrative data from

²The second intervention consisted of providing information about the malleability of intelligence through reading and discussion of a scientific article in class. Since the two interventions rely on different pedagogical approaches and implementation structures, we analyze the Pre-Texts arm separately in order to isolate the effects of this methodology on students' socioemotional and academic outcomes.

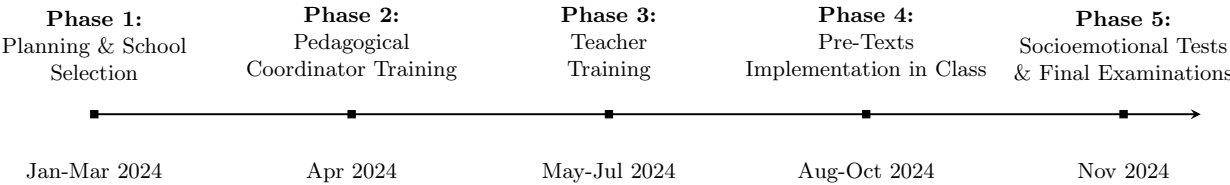
2017.³ Sixth-grade students in treated schools received one of the interventions, while those in the control group continued with their traditional teaching methods.

Prior to its implementation in primary education, the Pre-Texts methodology was introduced in Paraguay in 2020 through a program that trained local facilitators in higher education to strengthen four national universities. This previous experience facilitated its adaptation and scaling in the context studied here (Instituto Desarrollo 2020; Instituto Desarrollo 2020).

The implementation of the Pre-Texts intervention was structured across five sequential phases spanning the 2024 academic year,⁴ as summarized in Figure 3.1. The first phase, covering January through March, involved planning activities and school selection in coordination with the Departmental Directorates of the MEC. The second phase, in April, focused on training Pedagogical Coordinators (PCs)⁵ and introducing the core principles of the methodology through theoretical and practical workshops led by certified Pre-Texts facilitators and Professor Doris Sommer. During the third phase, covering May through July, trained PCs transferred the methodology to sixth-grade teachers through a cascade training model.

The fourth phase, comprising August through October, constituted the core implementation period, during which teachers conducted three weekly Pre-Texts sessions while PCs accompanied at least one session per week over ten weeks. The project team conducted field visits to monitor implementation fidelity and provide additional support whenever needed. The fifth and final phase, in November, encompassed the administration of socioemotional questionnaires and final examinations.⁶

Figure 3.1: Project Timeline



³At the moment of the randomization, these were the most recent available data from the Student Registry (RUE) collected by the MEC.

⁴In Paraguay, the academic year runs from February to November.

⁵Pedagogical Coordinators are responsible for accompanying, supervising, and providing ongoing feedback on teaching practices within educational institutions, acting as the nexus between school management and classroom practice, and ensuring the faithful implementation of the national curriculum (Ministerio de Educación y Ciencias 2007).

⁶More details of the intervention can be found in Appendix B3.

3.5 Data

This study combines administrative data from the MEC with data collected as part of the experiment. Below, we describe the different data sources.

Socioeconomic data. We use data from the Student Registry (RUE, Registro Único del Estudiante) to construct historic characteristics at the school level. These data include demographic, family, and housing information. The most recent available data correspond to 2017. Given that the randomization was conducted at the school level, we assume that these characteristics remain stable on average across schools over subsequent years.

To summarize socioeconomic conditions, we constructed a composite index using principal component analysis (PCA) based on household assets and housing characteristics. We recoded any necessary characteristics so that higher values consistently reflect better socioeconomic conditions. This index captures common variation across multiple correlated indicators and was used, together with district and school enrollment in 2022, to stratify schools prior to randomization. Remaining variables are used to assess balance across treated and control schools.

Socioemotional outcomes. To assess socioemotional skills, we administered a questionnaire at the end of the academic year. The instrument, developed by Professor Simone Di Plinio (University of Chieti-Pescara), builds on previous applications of the Pre-Texts methodology and has been adapted to the Paraguayan context to ensure age-appropriate and contextually relevant measurement (Osborn et al. 2023; Pica et al. 2024).

The questionnaire includes 65 Likert-scale questions covering emotions, schoolwork, and reading-related behaviors. To summarize these questions, we constructed indices that group related questions into domains of socioemotional skills. We recoded any necessary questions so that higher values consistently reflect better outcomes. The resulting indices capture dimensions such as emotional well-being, attention and effort, and reading motivation. More details on the construction of these indices are provided in Appendix C3.

Academic outcomes. Academic data include grades, and repetition rates. We observe final grades in Spanish and Mathematics for the 2024 academic year. We use the first midterm grades as baseline outcomes, corresponding to students’ achievement prior to the intervention. Because grades are based on school-specific assessments and are not standardized across schools, we constructed

indicator variables that equal one if a student obtained the highest possible grade of 5 on a scale from 1 to 5. This allows us to interpret the results as changes in the probability of achieving the top performance category. We acknowledge that these variables may partly reflect differences in grading practices across schools or teachers. We also use repetition rates from the 2024 and 2025 academic years as complementary measures of academic progression.

3.6 Empirical Strategy

This section describes the empirical approach we use to estimate the impact of the Pre-Texts methodology on socioemotional and academic outcomes. We start with a standard intention-to-treat framework to estimate average treatment effects. Next, we examine heterogeneous treatment effects. Finally, we detail some challenges encountered during the intervention and our empirical approach to addressing them.

3.6.1 Intention-To-Treat Specification

We estimate the causal effects of the Pre-Texts intervention using an intention-to-treat (ITT) framework. Because treatment was randomly assigned at the school level, identification relies on variation in treatment status across schools while outcomes are observed at the student level. Our baseline specification is given by

$$Y_{is} = \beta_0 + \beta_1 T_s + \delta Y_{is}^0 + \gamma_{strata(s)} + \varepsilon_{is} \quad (3.1)$$

where Y_{is} denotes an outcome of interest for student i in school s , T_s is an indicator equal to one if school s was assigned to the Pre-Texts intervention, and Y_{is}^0 is a baseline outcome used as a control whenever available. The term $\gamma_{strata(s)}$ represents fixed effects for the randomization strata, defined by district, school size, and historical socioeconomic conditions. Standard errors are clustered at the school level to account for within-school correlation in outcomes. The coefficient of interest, β_1 , captures the ITT effect of assignment to the intervention.

Our primary outcomes are socioemotional indices related to emotional well-being, attention and effort, and reading dimensions. Because the methodology combines literacy activities with

artistic and collaborative classroom practices, we expect effects to emerge particularly in dimensions associated with reading engagement and students’ attitudes toward learning. All socioemotional indices are standardized using the control group mean and standard deviation, allowing coefficients to be interpreted in standard deviation units.

We also examine academic outcomes, including the probability of achieving the highest grade in Spanish and Mathematics, as well as grade repetition. Because the Pre-Texts methodology centers on reading, interpretation, and collaborative classroom participation, improvements in students’ engagement with learning processes may translate into better academic performance.

3.6.2 Heterogeneous Effects

We then examine whether the effects of the intervention vary across student groups. In particular, we study heterogeneity by gender and school shift.⁷ These dimensions may shape how students respond to participatory and reading pedagogical approaches. For example, boys and girls may differ in reading engagement, classroom participation, and responses to collaborative learning environments. Likewise, morning, afternoon, and double shift schedules may differ in instructional conditions, student fatigue, classroom dynamics, and school organization, potentially affecting both the implementation and effectiveness of the Pre-Texts methodology.

We estimate heterogeneous effects by interacting the treatment indicator as follows

$$Y_{is} = \beta_0 + \beta_1 T_s + \beta_2 W_{is} + \beta_3 (T_s \times W_{is}) + \delta Y_{is}^0 + \gamma_{\text{strata}(s)} + \varepsilon_{is} \quad (3.2)$$

where W_{is} denotes a categorical characteristic of student i in school s , such as gender or school shift. The remaining variables are defined as before. The coefficient of interest, β_3 , allow the treatment effect to vary across subgroups. We compute marginal treatment effects separately for each category.

As an additional exploratory exercise, we estimate conditional quantile treatment effects for socioemotional outcomes to assess whether the intervention affected different parts of the outcome distribution differently. Specifically, we estimate quantile regressions at selected conditional quantiles of the outcome distribution.

⁷In Paraguay, most students attend school either in the morning or afternoon shifts. Recently, some schools have started implementing the double-shift schedule, in which students have classes from morning to afternoon.

3.6.3 Implementation Challenges and Intensity

Two implementation issues are relevant for interpreting the results. First, in one school assigned to the Pre-Texts intervention, the Pedagogical Coordinator attended the training sessions, but no evidence of classroom implementation was reported to the field team. Second, we identify a possible overlap in teacher names between one treated school and one control school. Since the field team only had direct contact with treated schools, we cannot confirm whether these records correspond to the same individual. Therefore, we interpret this only as a potential source of contamination. Consistent with the randomized design, these schools are retained in the main analysis under the ITT framework. Both issues are likely to attenuate estimated treatment effects by reducing the effective contrast between treatment and control schools. Consequently, the estimated ITT effects should be interpreted as conservative.

Implementation intensity also varied largely across treated schools and teachers. Although the project team established a target of 30 classroom sessions during the implementation period, the number of sessions ultimately delivered ranged from 0 to 30. Some schools also had multiple sixth-grade sections, with teachers implementing the methodology with varying intensity across classrooms. Consequently, students within the same school may have experienced different levels of exposure to the intervention.

To explore how implementation intensity relates to student outcomes, we complement the ITT analysis with descriptive specifications based on the number of sessions received by students. These analyses are exploratory and should not be interpreted causally, since implementation intensity was not randomly assigned and may reflect unobserved differences across teachers or schools.

Let c index classroom sections within school s . We assign to each student i the number of sessions delivered to their section, denoted S_{cs} . We then estimate

$$Y_{ics} = \alpha + \theta S_{cs} + \delta Y_{ics}^0 + \gamma_{\text{strata}(s)} + \varepsilon_{ics} \quad (3.3)$$

where we restrict the sample to students assigned to the Pre-Texts treatment group. The remaining variables are defined as before. The coefficient θ captures the association between the number of sessions received and an outcome of interest. Since the number of sessions was not

randomly assigned, this estimate should not be interpreted as a causal effect of implementation intensity.

3.7 Results

In this section, we present the main empirical results. We begin by assessing balance across treatment and control schools using available baseline outcomes and historical socioeconomic characteristics. We then estimate the average treatment effects of the Pre-Texts intervention on socioemotional and academic outcomes. Next, we explore heterogeneous effects across gender and school-shift categories. Finally, we examine whether implementation intensity is associated with stronger outcomes among students in treated schools.

3.7.1 Balance Checks

Table 3.1 presents balance tests for baseline outcomes, when available, and key demographic and socioeconomic characteristics at the school level. Columns (1) and (2) report the mean values and standard deviations for the control and treatment groups, respectively. Column (3) reports differences in means estimated from regressions of each variable on the treatment indicator, including fixed effects for the randomization strata. Column (4) reports p-values obtained using randomization inference procedures that account for the stratified design.⁸

Baseline academic outcomes include repetition rates and the probability of obtaining the highest score in Spanish and Mathematics from the first midterm of the 2024 academic year. These measures were collected prior to the classroom implementation of the intervention (which began in August 2024) and therefore provide pre-treatment academic outcomes for the cohort that entered sixth grade in 2024. In addition to baseline outcomes, we report school-level demographic and socioeconomic characteristics. These include enrollment size, gender composition, parental education and employment, and indicators of students' living conditions. Socioeconomic variables are obtained from the 2017 RUE survey and therefore reflect historical characteristics of the school population rather than contemporaneous conditions of the experimental cohort. The socioeconomic

⁸Instead of considering the study sample as drawn from a population to calculate p-values, randomization inference sees the study sample as the universe of eligible units. Hence, differences in outcomes are exact and come from treatment assignment. The method of randomization inference then tests the sharp null hypothesis that the treatment effect is zero for every unit (Young 2019; J-PAL 2026).

Table 3.1: Balance Checks

Variable	Control Mean (1)	Treatment Mean (2)	Difference (3)	P-value (4)
Repetition Rate	0.011 [0.035]	0.014 [0.062]	-0.001 (0.012)	0.959
Highest Score in Spanish	0.330 [0.145]	0.312 [0.150]	0.001 (0.029)	0.974
Highest Score in Mathematics	0.268 [0.127]	0.277 [0.144]	0.021 (0.030)	0.449
Enrollment Size	450.80 [213.06]	427.54 [261.62]	22.77 (27.57)	0.368
Female Students	0.486 [0.028]	0.484 [0.031]	-0.003 (0.007)	0.653
Socioeconomic Index	0.109 [1.021]	-0.031 [1.027]	-0.086 (0.220)	0.684
Spanish as Native Language	0.938 [0.095]	0.941 [0.079]	0.005 (0.019)	0.769
Father: High-School as Highest Degree	0.326 [0.084]	0.308 [0.095]	-0.019 (0.016)	0.210
Mother: High-School as Highest Degree	0.287 [0.079]	0.274 [0.085]	-0.014 (0.016)	0.363
Tutor: High-School as Highest Degree	0.218 [0.134]	0.183 [0.115]	-0.037 (0.030)	0.181
Father: Unemployed	0.042 [0.025]	0.042 [0.023]	-0.001 (0.005)	0.822
Mother: Unemployed	0.319 [0.095]	0.323 [0.085]	-0.014 (0.018)	0.464
Tutor: Unemployed	0.352 [0.147]	0.311 [0.154]	-0.048 (0.033)	0.109
Walking to Go to School	0.797 [0.150]	0.808 [0.144]	0.018 (0.034)	0.542
Arrive to School in Less Than 10 Minutes	0.952 [0.032]	0.943 [0.045]	-0.005 (0.009)	0.528
Schools	50	50		

Notes: Repetition rates and indicators for achieving the highest score in Spanish and Mathematics are based on the first midterm of the 2024 academic year and correspond to the experimental sixth-grade cohort. Enrollment size and the share of female students refer to the EEB (1° to 9° grades) in the 2023 academic year. The remaining variables are constructed from the 2017 RUE survey and aggregated at the school level. The socioeconomic index is constructed using principal component analysis based on household assets and housing characteristics and differs from the version used for stratification prior to randomization. Standard deviations are reported in [] and standard errors in (). *** p<0.01, ** p<0.05, * p<0.1.

index reported here differs from the version used for stratification, which was constructed prior to randomization using available information. While these variables were not collected specifically for the study sample, they capture persistent differences across schools.

Overall, the sample appears well balanced across treatment and control groups. None of the differences in means are statistically significant at conventional levels, and a joint test of baseline balance yields a p-value of 0.653 (also based on randomization inference), indicating that the null hypothesis of joint equality across groups cannot be rejected. These results provide support for the validity of the randomization.

3.7.2 Effects on Socioemotional Outcomes

We next examine the effects of the intervention. Table 3.2 reports the effects of the Pre-Texts intervention on socioemotional outcomes using equal-weighted standardized indices. Because baseline measures are not available for these outcomes, specifications do not include baseline controls. In general, estimated effects are modest in magnitude and statistically insignificant across most domains. The largest positive effects are observed for reading outcomes, particularly achievement-oriented reading motivation (0.069 standard deviations), social reading motivation (0.047 standard deviations), and reading enjoyment (0.047 standard deviations), although not significantly at conventional levels. In contrast, effects on emotional well-being (both negative and positive emotions) and attention and effort are close to zero. These results suggest that the intervention may have had a more immediate influence on students' attitudes and motivation toward reading activities than on more general emotional or behavioral outcomes.

These findings align with the structure of the Pre-Texts methodology, which centers reading, interpretation, and creative interaction with texts in classroom activities. These mechanisms may affect students' engagement with reading more rapidly than other socioemotional dimensions, such as emotional well-being or self-regulation, which may require longer exposure to evolve.

Similar findings have been documented in other contexts evaluating arts-based and active learning interventions. For example, [Osborn et al. 2023](#) find that the Pre-Texts methodology decreases depression and anxiety symptoms among adolescents in Kenya, while [Calero et al. 2017](#) report limited short-run effects of an arts-based youth program in Brazil on socioemotional dimensions. More generally, the literature suggests that arts-based pedagogical interventions tend to affect outcomes

Table 3.2: Effects on Socioemotional Outcomes

Variable	ITT Estimate
Negative Emotions	0.022 (0.041)
- Fear & Worry	0.025 (0.039)
- Sadness & Loneliness	0.016 (0.040)
Positive Emotions	0.016 (0.034)
- Happiness & Calmness	0.006 (0.030)
- Social Connectedness	0.023 (0.037)
Attention & Effort	0.011 (0.040)
Reading Barriers	0.022 (0.047)
Reading Enjoyment	0.047 (0.043)
Social Reading Motivation	0.047 (0.042)
Achievement-Oriented Reading Motivation	0.069 (0.046)
Observations	4,825

Notes: Outcomes are standardized equal-weighted indices normalized using the control group mean and standard deviation. Coefficients are interpreted in standard deviation units. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

more directly connected to engagement, motivation, and language-related dimensions (Bowen and Kisida 2023). Here, the concentration of estimated effects on reading enjoyment and reading motivation appears in line with the mechanisms emphasized by the Pre-Texts methodology.

Appendix Table A3.1 shows that these findings are robust to alternative index constructions based on Anderson 2008 and principal component analysis, with similar magnitudes and patterns across specifications. This consistency suggests that the results are not driven by the specific weighting scheme used to aggregate the underlying survey items. Additionally, we compute p-values using randomization inference procedures that account for the stratified design. These results are qualitatively similar to the inference based on cluster-robust standard errors and do not alter the conclusions (Appendix Table A3.3).

3.7.3 Effects on Academic Outcomes

Table 3.3 presents the effects of the Pre-Texts intervention on academic outcomes. Column (1) shows the coefficients obtained from estimating equation 3.1 without baseline outcomes as controls, while Column (2) includes them. In general, the results indicate limited impacts on grade progression and modest improvements in academic performance. The estimated effect on repetition in 2025 is small and statistically insignificant across specifications, with point estimates close to zero. This result is not particularly surprising given the low baseline repetition rates observed in the study context. In Paraguay, average repetition rates in public primary schools have historically remained relatively low, particularly in Asunción and the Central Department (Observatorio Educativo Ciudadano 2026), where the intervention was implemented. Consequently, there is limited scope for detecting meaningful changes in grade repetition over the study period.

We find evidence of positive effects on academic achievement in Spanish. While the specification without controls yields an imprecise estimate, including the baseline outcome as a control yields a statistically significant increase of 2.8 percentage points in the probability of obtaining the highest score. This represents an increase of approximately 7% relative to the control group mean. No comparable effects are found for Mathematics, where estimates are small and not statistically significant across specifications.

Even though improvements in academic performance were plausible given the intervention’s emphasis on engagement and classroom participation, the greater effects observed in Spanish align

Table 3.3: Effects on Academic Outcomes

Variable	Observations	Mean DV (Control)	ITT Estimate	
			(1)	(2)
Repetition	5,202	0.005	-0.002 (0.002)	-0.002 (0.002)
Highest Score in Spanish	5,233	0.410	0.024 (0.027)	0.028** (0.012)
Highest Score in Mathematics	5,182	0.341	0.022 (0.026)	0.006 (0.009)
Controls			No	Yes

Notes: Mean DV corresponds to the control group means of the outcome variable. For the repetition outcome, an indicator for repetition status in 2024 is included as a baseline control. For other academic outcomes, indicators for achieving the highest score in Spanish and Mathematics in the first midterm of the 2024 academic year are included as baseline controls. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

with the structure of the Pre-Texts methodology, which centers reading, interpretation, and creative engagement with texts. Existing evidence on arts-based and active learning interventions similarly tends to show stronger effects on language-related outcomes and student engagement than on Mathematics achievement. For example, [Bowen and Kisida 2023](#) report improvements in writing achievement and socioemotional outcomes but no significant effects on Mathematics scores, while [Calero et al. 2017](#) find no impacts on academic skills in a Brazilian arts-based intervention.

At the same time, the absence of significant effects on grade progression and the limited impacts on Mathematics suggest that the short-run academic effects of the intervention are modest. This pattern is not unexpected given the timing of the study, as outcomes are measured within the same academic year in which the intervention was implemented. This interpretation is supported by the broader literature on socioemotional learning interventions. [Bailey et al. 2020](#) argue that improvements in socioemotional skills often precede and predict later gains in academic performance, with effects unfolding over longer time horizons rather than within a single academic year. Similarly, [Durlak et al. 2011](#) document that school-based socioemotional programs tend to generate stronger academic effects over time as students internalize new motivational orientations and behavioral patterns. Likewise, [Ganimian 2020](#) argues that academic effects in domains such as Mathematics

may require longer periods to emerge. In this context, the concentration of short-run effects on reading motivation and enjoyment may reflect intermediate changes that could eventually translate into academic improvements. Whether these gains persist and strengthen over time remains an important question for future research.

As a robustness check, we estimate probit specifications to account for possible non-linear relationships between the outcomes and the treatment indicator. Appendix Table A3.2 shows that findings are robust to non-linear specifications. Furthermore, Appendix Table A3.3 reports randomization inference p-values for the academic outcomes. The results remain qualitatively similar to the cluster-robust inference reported in Table 3.3, though the effect on the probability of obtaining the highest score in Spanish is now significant at the 10% level.

We also assess potential attrition by examining whether treatment assignment affects the probability of being observed at the endline. We find no evidence of differential attrition across treatment and control groups. Detailed results are reported in Appendix Table A3.4.

3.7.4 Heterogeneous Effects

We then investigate whether the effects of the Pre-Texts methodology differ across student groups. Table 3.4 reports marginal treatment effects by gender (Columns (1)–(2)) and school shift (Columns (3)–(5)) on socioemotional outcomes. Findings reveal that the socioemotional effects of the intervention differ modestly across student groups, though most estimates remain statistically insignificant. Nevertheless, several patterns emerge. Across gender, treatment effects tend to be somewhat larger for boys than for girls, particularly for reading-related dimensions. For example, the estimated effect on achievement-oriented reading motivation is approximately 0.10 standard deviations for boys and statistically significant at the 10% level, while the corresponding estimate for girls is smaller and statistically insignificant. Similar conclusions emerge for reading enjoyment and social reading motivation, suggesting that boys may have responded more strongly to the methodology’s participatory and reading components. Regarding shift categories, morning- and afternoon-shift students generally display positive coefficients for reading-related dimensions, whereas morning-shift effects on emotions are small and negative (none is statistically significant). Double-shift students (students attending school from morning to afternoon) often exhibit relatively large positive point estimates across several socioemotional outcomes, particularly positive emotions, and

attention and effort, although these estimates are imprecisely estimated due to the smaller sample size of double-shift students.

Table 3.4: Heterogeneous Effects on Socioemotional Outcomes

Variable	Girls (1)	Boys (2)	Morning (3)	Afternoon (4)	Double (5)
Negative Emotions	0.023 (0.055)	0.020 (0.055)	-0.015 (0.055)	0.057 (0.057)	0.145 (0.117)
- Fear & Worry	0.042 (0.054)	0.007 (0.054)	-0.036 (0.051)	0.096 (0.058)	0.121 (0.119)
- Sadness & Loneliness	-0.0001 (0.052)	0.031 (0.052)	0.008 (0.054)	0.010 (0.056)	0.149 (0.109)
Positive Emotions	-0.005 (0.050)	0.038 (0.048)	-0.013 (0.036)	0.039 (0.068)	0.278 (0.183)
- Happiness & Calmness	-0.009 (0.047)	0.021 (0.042)	-0.025 (0.034)	0.030 (0.066)	0.243 (0.147)
- Social connectedness	-0.002 (0.051)	0.049 (0.052)	-0.0001 (0.039)	0.042 (0.065)	0.275 (0.201)
Attention & Effort	-0.008 (0.049)	0.029 (0.052)	-0.046 (0.052)	0.073 (0.054)	0.257 (0.292)
Reading Barriers	0.0002 (0.051)	0.041 (0.061)	-0.032 (0.059)	0.084 (0.059)	0.156 (0.223)
Reading Enjoyment	0.008 (0.052)	0.085 (0.055)	0.045 (0.054)	0.045 (0.057)	0.093 (0.151)
Social Reading Motivation	0.026 (0.051)	0.067 (0.055)	0.052 (0.053)	0.030 (0.060)	0.207 (0.148)
Achievement-Oriented Reading Motivation	0.041 (0.058)	0.096* (0.054)	0.065 (0.053)	0.071 (0.066)	0.111 (0.139)
Observations	4,825				

Notes: Outcomes are standardized equal-weighted indices normalized using the control group mean and standard deviation. In Columns (1)–(2), coefficients represent the marginal treatment effects for girls and boys, respectively. In Columns (3)–(5), coefficients are the marginal treatment effects for students in morning, afternoon, and double shifts, respectively. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

For repetition outcomes, the impact is, in general, small and not distinguishable from zero by gender and shift, as shown in Table 3.5. The exception is the effect on afternoon-shift students, for whom repetition rates decline modestly, significant at the 10% level, but the magnitude is small in absolute terms given the low baseline repetition rate. In contrast, differences across school shifts appear more pronounced for other academic outcomes. Students attending morning shifts exhibit

more favorable academic achievement responses to the intervention than students in afternoon and double shifts. In particular, morning-shift students experience a statistically significant increase of approximately 5.4 percentage points in the probability of obtaining the highest score in Spanish, relative to a control group mean of 41%.

Table 3.5: Heterogeneous Effects on Academic Outcomes

Variable	Observations	Mean DV (Control)	Girls (1)	Boys (2)	Morning (3)	Afternoon (4)	Double (5)
Repetition	5,202	0.005	-0.004 (0.002)	0.0004 (0.004)	0.001 (0.003)	-0.006* (0.003)	0.001 (0.001)
Highest Score in Spanish	5,233	0.410			0.054*** (0.016)	-0.010 (0.016)	0.050 (0.043)
Highest Score in Mathematics	5,182	0.341			0.022 (0.014)	-0.011 (0.013)	-0.030 (0.026)

Notes: Mean DV corresponds to the control group means of the outcome variable. For the repetition outcome, an indicator for repetition status in 2024 is included as a baseline control. For other academic outcomes, indicators for achieving the highest score in Spanish and Mathematics in the first midterm of the 2024 academic year are included as baseline controls. In Columns (1)–(2), coefficients represent the marginal treatment effects for girls and boys, respectively. In Columns (3)–(5), coefficients are the marginal treatment effects for students in morning, afternoon and double shifts, respectively. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Finally, Appendix Table A3.5 explores heterogeneity across the conditional distribution of socioemotional outcomes using quantile regressions. We add the ITT estimates in Column (1) alongside the quantile specifications in Columns (2)–(6) to facilitate comparison between average and distributional treatment effects. The quantile estimates are, in general, similar to the average ITT effects reported in Column (1), providing limited evidence of strong distributional heterogeneity. The estimated effects are generally modest and concentrated around intermediate quantiles for selected positive emotions and reading outcomes.

3.7.5 Implementation Intensity

As highlighted in Section 3.6, implementation of the Pre-Texts methodology was not homogeneous across treated schools. Some teachers implemented the methodology more intensively than others. Figure 3.2 verifies this variation by sixth-grade section, with the number of Pre-Texts sessions ranging from 0 to 30 and a concentration of observations at relatively low levels of exposure. Although the intervention target was 30 sessions, the distribution indicates that many teachers implemented fewer sessions in practice, highlighting the operational challenges associated

with scaling the methodology across schools and classroom environments. This variation provides useful descriptive evidence on how differential exposure to the intervention is associated with socioemotional and academic outcomes, but these relationships should not be interpreted causally given the non-random nature of implementation intensity.

Figure 3.2: Distribution of Pre-Texts Sessions

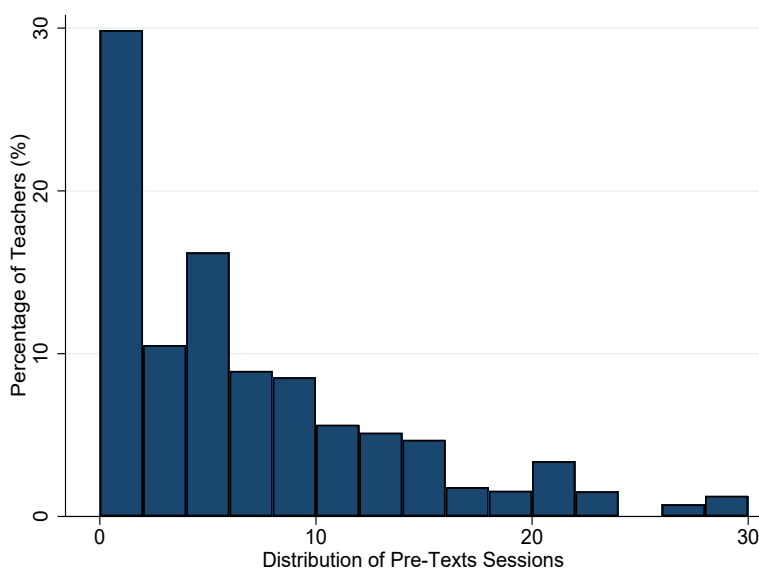


Table 3.6 presents the relationship between socioemotional outcomes and the number of sessions in treated schools (equation 3.3 without baseline controls). Column (1) reports the coefficients per additional session. In Column (2), sessions are standardized with mean 0 and standard deviation 1. In Columns (3)–(5), sessions are classified in three categories: 1-10 sessions, 11-20 sessions and 21 and more sessions. Thus, coefficients are interpreted relative to the omitted category (students in treated schools exposed to 0 sessions). Results suggest that higher implementation intensity is associated with increases in reading outcomes rather than in emotional well-being outcomes. The estimated coefficients for negative emotions, positive emotions, attention and effort, and reading barriers are generally small and statistically insignificant across specifications. On the contrary, the results point to more positive associations for reading enjoyment and reading motivation. More specifically, an additional session is associated with increases of approximately 0.011 standard deviations in social reading motivation and 0.012 standard deviations in achievement-oriented reading motivation, with both estimates statistically significant at the 10% level. Standardizing the session

variable yields similar results, indicating that a one standard deviation increase in implementation intensity is associated with gains of roughly 0.08 standard deviations in these outcomes. Likewise, the categorical specifications suggest that these relationships may be nonlinear. In particular, students exposed to more than 20 sessions exhibit larger improvements in social reading motivation relative to students exposed to zero sessions (significant at the 10% level), while lower exposure categories display considerably smaller coefficients. Even though estimates for reading enjoyment and achievement-oriented reading motivation are not statistically significant, they also increase monotonically with implementation intensity, suggesting that more sustained exposure to the methodology may be necessary to generate detectable changes in reading outcomes.

For academic outcomes, implementation intensity is assigned at the school-shift level because we were not able to match students to implementation records. Therefore, we constructed the average number of sessions delivered within each school and shift and assigned this value to all students in the corresponding group. Table 3.7 reveals limited evidence that implementation intensity translated into improvements in short-run academic performance. The estimated associations for repetition and mathematics achievement are close to zero and statistically insignificant across specifications. For Spanish achievement, the specification that includes baseline controls indicates a small positive association between average sessions and the probability of obtaining the highest score, but the magnitude remains modest.

As a robustness check, we augment the specifications with school-level average academic performance from an earlier sixth-grade cohort (2023 academic year). The estimates in Appendix Table A3.6 remain qualitatively unchanged, suggesting that the significant positive association between implementation intensity and Spanish performance is not primarily driven by persistent differences in school-level academic quality.

In general, the descriptive associations suggest that greater exposure to the intervention is more consistently associated with reading engagement and reading motivation than with other socioemotional or academic outcomes. In particular, students exposed to more sessions appear to exhibit stronger reading motivation and enjoyment. However, these relationships should be interpreted cautiously, since implementation intensity was not randomly assigned and may reflect differences in teacher engagement, school organization, or classroom conditions. Consequently, these estimates should be interpreted as descriptive correlations rather than causal effects of different intensity.

Table 3.6: Socioemotional Outcomes & Pre-Texts Sessions

Variable	Number of Sessions (1)	Standardized Sessions (2)	1–10 Sessions (3)	11–20 Sessions (4)	21+ Sessions (5)
Negative Emotions	0.003 (0.005)	0.022 (0.031)	-0.149 (0.102)	-0.017 (0.131)	-0.075 (0.123)
- Fear & Worry	0.005 (0.004)	0.031 (0.029)	-0.140 (0.087)	-0.027 (0.121)	0.005 (0.113)
- Sadness & Loneliness	0.001 (0.005)	0.009 (0.031)	-0.138 (0.104)	-0.005 (0.129)	-0.146 (0.121)
Positive Emotions	0.0002 (0.004)	0.001 (0.028)	-0.064 (0.113)	-0.101 (0.124)	-0.055 (0.147)
- Happiness & Calmness	-0.0004 (0.005)	-0.003 (0.032)	-0.044 (0.111)	-0.102 (0.129)	-0.076 (0.165)
- Social Connectedness	0.001 (0.004)	0.005 (0.024)	-0.074 (0.109)	-0.088 (0.114)	-0.028 (0.129)
Attention & Effort	-0.003 (0.005)	-0.022 (0.032)	-0.113 (0.140)	-0.057 (0.171)	-0.165 (0.145)
Reading Barriers	0.004 (0.006)	0.028 (0.044)	-0.104 (0.148)	-0.001 (0.173)	0.097 (0.226)
Reading Enjoyment	0.010 (0.006)	0.069 (0.041)	0.033 (0.132)	0.119 (0.143)	0.297 (0.216)
Social Reading Motivation	0.011* (0.006)	0.076* (0.039)	0.024 (0.113)	0.087 (0.119)	0.358* (0.206)
Achievement-Oriented Reading Motivation	0.012* (0.006)	0.079* (0.043)	0.010 (0.127)	0.060 (0.134)	0.362 (0.226)
Observations	2,269				

Notes: Outcomes are standardized equal-weighted indices normalized using the control group mean and standard deviation. Coefficients in column (1) are expressed per additional session. Coefficients in column (2) are interpreted per additional standard deviation unit. Coefficients in Columns (3)–(5) are interpreted relative to the omitted category (students exposed to 0 sessions). All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table 3.7: Academic Outcomes & Pre-Texts Sessions

Variable	Observations	Average Sessions	
		(1)	(2)
Repetition	2,489	-0.001 (0.000)	-0.001 (0.000)
Highest Score in Spanish	2,502	-0.002 (0.002)	0.003* (0.002)
Highest Score in Mathematics	2,480	-0.004 (0.003)	-0.0003 (0.001)
Controls		No	Yes

Notes: For the repetition outcome, an indicator for repetition status in 2024 is included as a baseline control. For other academic outcomes, indicators for achieving the highest score in Spanish and Mathematics in the first midterm of the 2024 academic year are included as baseline controls. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

3.8 Conclusion

This paper provides experimental evidence on the effects of the Pre-Texts methodology, an arts-based and active learning intervention implemented among sixth-grade students in Paraguayan public schools. The results indicate modest but suggestive evidence that the intervention primarily affected reading-related dimensions of students' educational experiences. In particular, the estimated effects are consistently more positive for outcomes associated with reading enjoyment and reading motivation than for emotional well-being, attention, and effort. We also find some evidence of improvements in Spanish academic achievement, while effects on Mathematics and grade repetition are generally limited. Exploratory analyses suggest that greater implementation intensity is associated with stronger reading motivation and engagement, although these relationships should be interpreted cautiously given the non-random variation in implementation intensity across schools and teachers.

Findings suggest that the Pre-Texts methodology may operate primarily through mechanisms related to students' engagement with reading and classroom participation rather than through short-run transformations in socioemotional well-being. This interpretation is consistent with the

structure of the intervention itself, which places collective reading, interpretation, artistic production, and collaborative participation at the center of classroom activities. More generally, the results highlight the potential importance of pedagogical approaches that seek to strengthen students' relationship with learning processes rather than focusing exclusively on direct academic instruction.

The paper also documents important implementation challenges associated with scaling pedagogical innovations in public school systems. Implementation intensity varied largely across teachers and schools, which may reflect differences in classroom conditions, organizational capacity, and teacher engagement. These challenges are particularly relevant for interventions that depend heavily on teacher participation and sustained classroom interaction. Therefore, the results underscore the importance of designing innovative pedagogical methodologies and ensuring institutional conditions that facilitate consistent implementation.

Several limitations must be acknowledged. First, socioemotional outcomes were measured only at the endline, preventing the inclusion of baseline controls for these variables. Second, implementation intensity was not randomly assigned, limiting the interpretation of intensity analyses. Third, academic outcomes rely on administrative school records rather than standardized assessments of Spanish and Mathematics achievement. Consequently, the estimated academic effects may partly reflect differences in grading practices across schools or teachers. Finally, the intervention was implemented during a relatively short period of the academic year, which may constrain the emergence of greater academic or socioemotional effects. More specifically, changes in reading engagement and classroom participation may require longer periods of sustained exposure before translating into larger academic gains.

Future research could explore whether the effects of arts-based pedagogical interventions accumulate over time and whether repeated exposure across multiple academic years generates stronger impacts on academic achievement and socioemotional development. Additional work could also examine how implementation support, teacher training, and institutional capacity shape the effectiveness of participatory pedagogical methodologies in public school systems. More generally, understanding how schools can foster students' engagement with reading and learning remains an important challenge for education policy in contexts characterized by persistent learning deficits.

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A3 Appendix: Additional Tables

Table A3.1: Effects on Socioemotional Outcomes - Alternative Indices

Variable	ITT Estimate	
	(1)	(2)
Negative Emotions	0.009 (0.039)	0.018 (0.041)
- Fear & Worry	0.017 (0.038)	0.024 (0.039)
- Sadness & Loneliness	0.004 (0.038)	0.012 (0.039)
Positive Emotions	0.020 (0.032)	0.016 (0.034)
- Happiness & Calmness	0.015 (0.030)	0.006 (0.030)
- Social connectedness	0.028 (0.036)	0.023 (0.037)
Attention & Effort	0.011 (0.038)	0.012 (0.040)
Reading Barriers	0.020 (0.045)	0.021 (0.047)
Reading Enjoyment	0.046 (0.040)	0.046 (0.042)
Social Reading Motivation	0.050 (0.042)	0.045 (0.041)
Achievement-Oriented Reading Motivation	0.072 (0.046)	0.070 (0.046)
Observations	4,825	4,825

Notes: In Column (1), outcomes are standardized Anderson indices normalized using the control group mean and standard deviation. In Column (2), outcomes are standardized principal component analysis indices normalized using the control group mean and standard deviation. Coefficients are interpreted in standard deviation units. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A3.2: Non-Linear Effects on Academic Outcomes

Variable	Observations	Mean DV (Control)	ITT Estimate	
			(1)	(2)
Repetition	2,626	0.011	-0.004 (0.005)	-0.004 (0.005)
Highest Score in Spanish	5,233	0.410	0.023 (0.027)	0.030** (0.013)
Highest Score in Mathematics	5,170	0.341	0.021 (0.026)	0.007 (0.009)
Controls			No	Yes

Notes: Mean DV corresponds to the control group means of the outcome variable. For the repetition outcome, an indicator for repetition status in 2024 is included as a baseline control. For other academic outcomes, indicators for achieving the highest score in Spanish and Mathematics in the first midterm of the 2024 academic year are included as baseline controls. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A3.3: Randomization Inference on Main Outcomes

Variable	P-value
Negative Emotions	0.651
- Fear & Worry	0.592
- Sadness & Loneliness	0.733
Positive Emotions	0.694
- Happiness & Calmness	0.848
- Social Connectedness	0.616
Attention & Effort	0.815
Reading Barriers	0.668
Reading Enjoyment	0.292
Social Reading Motivation	0.262
Achievement-Oriented Reading Motivation	0.142
Repetition	0.511
Repetition (Baseline Outcome as Control)	0.533
Highest Score in Spanish	0.424
Highest Score in Spanish (Baseline Outcome as Control)	0.060*
Highest Score in Mathematics	0.457
Highest Score in Mathematics (Baseline Outcome as Control)	0.597

Notes: P-values are obtained using randomization inference procedures that account for the stratified design. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A3.4: Attrition Checks

Variable	Repetition		Highest Score in Spanish		Highest Score in Mathematics	
	(1)	(2)	(3)	(4)	(5)	(6)
Treatment	0.008 (0.005)	0.008 (0.005)	0.003 (0.006)	0.002 (0.006)	0.006 (0.009)	0.006 (0.010)
Observations	5,359	5,359	5,433	5,353	5,433	5,354

Notes: Each column reports coefficients from regressions of an indicator for being observed in the corresponding endline outcome on the treatment indicator. Columns (1), (3) and (5) define attrition unconditionally for all students in the 2024 sixth-grade cohort. Columns (2), (4) and (6) restrict the sample to students observed at baseline. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A3.5: Conditional Quantile Treatment Effects for Socioemotional Outcomes

Variable	ITT Estimate	Q10	Q25	Q50	Q75	Q90
	(1)	(2)	(3)	(4)	(5)	(6)
Negative Emotions	0.022 (0.041)	0.004 (0.006)	-0.003 (0.005)	-0.002 (0.003)	-0.002 (0.004)	-0.013 (0.023)
- Fear & Worry	0.025 (0.039)	0.004 (0.006)	-0.002 (0.004)	-0.001 (0.003)	-0.002 (0.003)	0.000 (0.012)
- Sadness & Loneliness	0.016 (0.040)	0.005 (0.008)	-0.001 (0.005)	-0.004 (0.003)	-0.001 (0.002)	0.000 (0.010)
Positive Emotions	0.016 (0.034)	0.011 (0.009)	0.007* (0.004)	0.009** (0.005)	0.011 (0.007)	0.026 (0.026)
- Happiness & Calmness	0.006 (0.030)	0.011 (0.008)	0.010* (0.006)	0.001 (0.005)	-0.001 (0.006)	-0.000 (0.013)
- Social Connectedness	0.023 (0.037)	0.015 (0.011)	0.008* (0.004)	0.009*** (0.003)	0.001 (0.003)	-0.000 (0.005)
Attention & Effort	0.011 (0.040)	0.006 (0.004)	0.002 (0.004)	0.001 (0.004)	-0.003 (0.004)	-0.010 (0.008)
Reading Barriers	0.022 (0.047)	-0.004 (0.004)	-0.002 (0.003)	-0.002 (0.004)	-0.007* (0.004)	-0.000 (0.016)
Reading Enjoyment	0.047 (0.043)	-0.0002 (0.006)	-0.008** (0.003)	-0.008*** (0.002)	-0.001 (0.003)	0.007 (0.013)
Social Reading Motivation	0.047 (0.042)	0.0002 (0.007)	0.0003 (0.007)	-0.0004 (0.008)	-0.0001 (0.007)	0.000 (0.007)
Achievement-Oriented Reading Motivation	0.069 (0.046)	-0.005 (0.006)	0.0001 (0.004)	-0.008** (0.004)	0.001 (0.005)	0.033 (0.024)
Observations	4,825					

Notes: Outcomes are standardized equal-weighted indices normalized using the control group mean and standard deviation. Column (1) has the ITT estimates. In columns (2)–(6), coefficients represent the conditional quantile treatment effect at the 10th, 25th, 50th, 75th, and 90th percentiles, respectively. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** p<0.01, ** p<0.05, * p<0.1.

Table A3.6: Academic Outcomes & Pre-Texts Sessions: Earlier Cohort Grades as Control

Variable	Observations	Average Sessions
Highest Score in Spanish	2,503	0.003* (0.002)
Highest Score in Mathematics	2,480	-0.0003 (0.001)

Notes: Indicators for achieving the highest score in Spanish and Mathematics in the first midterm of the 2024 academic year are included as baseline controls. Regressions additionally control for school-level average indicators of achieving the highest score in Spanish and Mathematics among sixth-grade students in 2023. All regressions include randomization-strata FE. Standard errors clustered at the school level are reported in (). *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

B3 Appendix: Implementation and Training Details of the Pre-Texts Intervention

This appendix provides additional operational details on the implementation and training processes for the Pre-Texts intervention. These details complement the summary presented in Section 3.4 and document the sequence of activities, training procedures, and implementation support mechanisms carried out during the 2024 academic year.

Prior to its implementation in primary education, the Pre-Texts methodology had already been introduced in Paraguay in 2020 through a program that trained local higher-education facilitators to strengthen four national universities (Instituto Desarrollo 2020; Instituto Desarrollo 2020). This previous experience facilitated the adaptation and scaling of the methodology in the context studied here.

The implementation process was organized into five sequential phases spanning the 2024 academic year:

Phase 1. January-March 2024. The first phase involved planning activities and school selection in coordination with the Departmental Directorates of the MEC.

Phase 2. April 2024. The second phase began on April 10th with an inaugural session led virtually by Professor Sommer, in which she presented the Pre-Texts methodology and its manual to school directors and Pedagogical Coordinators (PCs). This was followed by the formal training of PCs, conducted over two full days between April 22nd and 26th by certified Pre-Texts facilitators. The training comprised two theoretical workshops—covering the foundational principles of the methodology and the elaboration of lesson plans—and one practical workshop, in which PCs rehearsed the four core moments of the protocol: oral reading, dialogic discussion, reflective writing, and artistic production. Of the 50 treatment schools invited, 36 PCs participated. The remaining 14 did not attend due to prior institutional commitments, absence, or the absence of an assigned PC in their school. Compensation strategies were established, such as forming collaborative working groups, to ensure that coordinators unable to attend received knowledge transfer from their colleagues. A PC was considered qualified upon attendance at a minimum of three sessions.

Phase 3. May-July 2024. The third phase consisted of the technical transfer from PCs

to sixth-grade teachers, organized in groups of three to four PCs. To address the gap left by 17 teachers who had not been trained during this phase, a reinforcement session replicating the two theoretical workshops was held on July 30th and 31st, ensuring that all participating teachers could begin implementation simultaneously in August.

The training reached representatives of all 50 treatment schools. Representatives of 49 schools attended the in-person training sessions, comprising 53 Pedagogical Coordinators, 2 teachers, 2 school directors, and 2 technical staff members. For the one school that lacked a Pedagogical Coordinator, the Instituto Desarrollo team traveled directly to the institution to train a teacher on-site. Subsequently, 69 additional teachers were trained by institutional representatives (Pedagogical Coordinators, directors, or technical staff) who had attended the initial sessions, completing the cascade model through which the methodology reached all participating schools.

Phase 4. August-October 2024. The fourth phase constituted the core implementation period, during which teachers conducted three weekly Pre-Texts sessions while PCs accompanied at least one session per week over ten weeks. The project team—composed of five Instituto Desarrollo staff members—conducted field visits to monitor implementation fidelity and provide additional support whenever needed. Although all treated schools received training, implementation intensity varied largely across schools and teachers during the classroom implementation phase. In particular, at one treatment school, the field team did not receive evidence of classroom implementation, despite the PC's participation in the training activities.

Phase 5. November 2024. The fifth and final phase consisted of administering socioemotional questionnaires and final examinations.

C3 Appendix: Measurement of Socioemotional Outcomes

C3.1 Index Construction

To assess the socioemotional effects of the Pre-Texts intervention, we administered a questionnaire designed to capture students' emotions, schoolwork, and reading habits. The questionnaire was elaborated by Professor Simone Di Plinio (University of Chieti-Pescara), ensuring a neutral entry experience for sixth-grade students in Paraguayan public schools (Pica et al. 2024). The questionnaire comprised 65 5-point Likert-scale questions grouped into seven blocks. These questions were aggregated into composite indices, with any necessary recoding to ensure that higher values reflect better skills. We defined the following indices: (i) negative emotions, subdivided into fear and worry, and sadness and loneliness; (ii) positive emotions, subdivided into happiness and calmness, and social connectedness; (iii) attention and effort; (iv) reading barriers; (v) reading enjoyment; (vi) social reading motivation; and (vii) achievement-oriented reading motivation. We first standardized individual items using the control group mean and standard deviation, and then re-standardized the resulting indices so that all outcomes are expressed in standard deviation units.

We constructed indices using three methods: equal-weighted, Anderson, and principal component analysis (PCA). In all cases, we first recoded and standardized answers and then constructed the indices. The equal-weighted index provides a transparent aggregation of standardized variables. The Anderson index assigns weights based on the inverse covariance matrix, reducing the influence of highly correlated variables. The PCA index summarizes the main dimension of variation across variables. Comparing results across these methods allows us to assess the robustness of our findings to alternative weighting schemes.

For the equal-weighted method, we aggregated answers as follows

$$\text{Index}_{isd} = \frac{1}{Q_d} \sum_{j \in d} z_{isj} \quad (3.4)$$

where Index_{isd} is a socioemotional index of student i of school s of domain d , Q_d is the number of questions in domain d and z_{isd} is a standardized answer of student i of school s of domain d .

The Anderson method (Anderson 2008), also known as the inverse covariance weighted index, was constructed as

$$\text{Index}_{isd} = \mathbf{w}' \mathbf{z}_{isd}, \quad \mathbf{w} = \frac{\mathbf{\Sigma}^{-1} \mathbf{1}}{\mathbf{1}' \mathbf{\Sigma}^{-1} \mathbf{1}} \quad (3.5)$$

where $\mathbf{\Sigma}^{-1}$ is the covariance matrix of $\mathbf{z}_{isd}$ and $\mathbf{1}$ is a vector of ones. Weights $\mathbf{w}$ sum to 1.

Finally, we constructed PCA indices using the first principal component of the standardized variables within each domain. PCA identifies a linear combination of variables that maximizes the variance explained by a single latent factor. We used the unrotated first component, which is standard in the literature.

To assess the reliability of each index, we computed Cronbach's alpha. Cronbach's alpha was computed for each group of items used to construct the indices. Since all index construction methods rely on the same underlying set of variables, internal consistency was assessed once at the item level and was independent of the aggregation method. Values above 0.7 are typically interpreted as indicating acceptable internal consistency. Appendix Table C3.1 reports the alpha coefficients for each domain, showing that the indices exhibit satisfactory reliability. These results support the aggregation of individual items into domain-specific indices.

Table C3.1: Internal Consistency of Socioemotional Indices

Index	Cronbach's Alpha
Negative Emotions	0.898
- Fear & Worry	0.815
- Sadness & Loneliness	0.843
Positive Emotions	0.898
- Happiness & Calmness	0.816
- Social Connectedness	0.852
Attention & Effort	0.941
Reading Barriers	0.893
Reading Enjoyment	0.909
Social Reading Motivation	0.802
Achievement-Oriented Reading Motivation	0.872

C3.2 Socioemotional Questionnaire

We detail the composition of each index below.

1. **Negative emotions:** This index is composed of two subindices, fear and worry, and sadness and loneliness. The first subindex includes the following questions regarding emotions after

class:

- (a) I am afraid to go out alone.
- (b) It is hard to be with my friends.
- (c) It is difficult to do tasks because of nerves or worry.
- (d) I feel scared.
- (e) I feel worried about being at home.
- (f) I feel concerned.
- (g) I am worried that my health may get worse.
- (h) I am worried about doing well in school.

The second subindex also refers to emotions after class:

- (a) I am too sad to do things with friends.
- (b) I feel sad.
- (c) I feel alone.
- (d) I feel less interested in doing the things I like.
- (e) It is hard to get interested in anything.
- (f) It is hard to have fun.
- (g) I feel like I cannot do anything right.
- (h) I feel like everything is going wrong for me.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Not at all” and 5 was “A lot.”

2. **Positive emotions:** This index is also composed of two subindices, happiness and calmness, and social connectedness. The first subindex includes the following questions regarding emotions after class:

- (a) I feel happy.
- (b) I feel very good.

- (c) I feel excited.
- (d) I feel full of joy.
- (e) I feel in a good mood.
- (f) I feel rested.
- (g) I feel cool.
- (h) I feel calm.

The second subindex refers to the following emotions after class:

- (a) I feel close to my friends.
- (b) I feel like my friends are by my side.
- (c) I feel comfortable with other people my age.
- (d) I feel happy with the friends I have.
- (e) I feel good talking to my friends.
- (f) I feel like I had a fun time with my friends.
- (g) I feel that my friends and I have helped each other.
- (h) I feel like I have fun with my friends.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Not at all” and 5 was “A lot.”

3. **Attention and effort:** This index is comprised of the following questions:

- (a) I forget the tasks I have to do.
- (b) I forget what I was going to say.
- (c) I react slower than my classmates when we play.
- (d) I forget things easily.
- (e) I have a hard time remembering to do things, like homework.
- (f) I find it difficult to concentrate at school.
- (g) I have a hard time paying attention to teachers.

(h) I try very hard to pay attention, or else I make a mistake.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Never” and 5 was “Always.”

4. **Reading barriers:** This index captures the following reading barriers:

- (a) I read little because I have trouble finding books.
- (b) I have little time to read.
- (c) I read little because I find it difficult to understand what I read.
- (d) I do not read much because I think most books and stories are not interesting.
- (e) I feel embarrassed to read in front of a group.
- (f) I read little because there are not many books that catch my attention.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Totally disagree” and 5 was “Totally agree.”

5. **Reading enjoyment:** This index contains questions regarding lecture interest:

- (a) I read because books and stories are fascinating.
- (b) I read because sometimes I can forget everything around me.
- (c) I read because it is exciting to see what happens to the main character in a story.
- (d) I read because I can learn something new.
- (e) I read because that way I can learn more about interesting things.
- (f) I read because it is fun.
- (g) I read more when the teacher is covering something interesting.
- (h) I read because it is fun to get into a story.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Totally disagree” and 5 was “Totally agree.”

6. **Social reading motivation:** This index considers questions about people’s perception of reading habits:

- (a) I read because I know that my classmates also read a lot.
- (b) I read because I like people to think I am a good reader.
- (c) I read because my family thinks it is important for me to read a lot.
- (d) I read because other people say it is good to read a lot.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Totally disagree” and 5 was “Totally agree.”

7. **Achievement-oriented reading motivation:** This index summarizes questions about lecture interest based on grade motivation and self-perception:

- (a) I read to obtain better grades.
- (b) I read because it is important for me to understand things better than my classmates.
- (c) I read because it is important for me to be one of the best students.
- (d) I read because I want to be better than others in my class.
- (e) I read because it helps me improve in school.
- (f) I read because it helps me do well in some subjects.
- (g) I read because it is important to me to always be the best at reading.

Students were instructed to mark one option on a scale from 1 to 5, where 1 was “Totally disagree” and 5 was “Totally agree.”