Regional unconditional transfers: the case of riverside regions in a developing country

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Submitted as a requirement to opt for the degree of
Master in Economics

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December 2025

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Abstract

Disadvantaged communities worldwide have often been the focus of government-sponsored programs aimed at improving living standards and fostering economic development. Decentralization has emerged as a central strategy in this effort, aiming to enhance governance by shifting decision-making closer to citizens, strengthening accountability, and promoting local development, a trend to which Colombia, as a middle-income country, is no exception. This paper examines the effects of a regionally targeted transfer program that allocated additional resources to municipalities allocated along the Magdalena River, the longest country's waterway. To identify causal impacts, I exploit the 2002 reform that significantly reduced these transfers and apply a difference-in-differences approach using panel data for the period 1994-2019. The findings reveal no effects on social outcomes but slowdown in economic activity, accompanied by reductions in municipal operating expenditures and investment, while revealing an increase in tax revenues. These results highlight the complex interplay between fiscal decentralization and regional development, raising important questions about the effectiveness of targeted transfers in achieving their intended objectives.

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1 Introduction

Transfers of political, administrative, and fiscal responsibilities from national to subnational governments have been analyzed over decades in many countries with different characteristics and political ideologies. Decentralization emerged as a response to the need for improved governance and as potential remedy for the deprivation experienced by local communities in accessing essential public goods and services, particularly health, education, and basic sanitation (Besley and Coate, 2003; Faguet, 2004; Bergvall *et al*., 2006; Del Valle and Galindo, 2010; Brosio and Jimenez, 2012). The other rationale behind the rise of decentralization, closely linked to the previous one, has been the increasing pattern of regional disparities (Brosio and Jimenez, 2012; Panzera and Postiglione, 2021; Marchand *et al*., 2020; McCann, 2020; Pike *et al*., 2010). The presence and persistence of such imbalances are the reasons why the economies have decided to implement policies aimed at improving the standard of living in the lagging regions within their countries (Bonet *et al*., 2023).

Disadvantaged and distressed communities have frequently been the target of governments' sponsored programs aimed at fostering growth and improving their quality of life (Oakley and Tsao, 2006; Accetturo and De Blasio, 2012). National and local authorities have also tested several mechanisms through which less developed communities are the recipients of financial aid. Within the most commonly used programs and policies are: regionally targeted tax incentives (Billings, 2009; Hanson and Rohlin, 2013; Reynolds and Rohlin, 2015; Blouri and Ehrlich, 2020), intra-urban spatially targeted economic initiatives (Krupka and Noonan, 2009; Feyrer and Sacerdote, 2011), population thresholds (Corbi *et al*., 2017), and some other regional-specific characteristics (Becker *et al*., 2013; Corbi *et al*., 2014; Corbi *et al*., 2019).

For the particular case of Colombia, regional disparities have largely been discussed and analyzed. The literature has found the results to be anything but robust, specially depending on the period covered, and the data and methodology used. Some researchers have found a reduction of disparities over the years (Cárdenas *et al*., 1993; Gómez, 2006; Royuela and García, 2015; León and Benavides, 2015), while the most recently published research have shown evidence of increasing regional disparities (Bonet and Meisel, 1999; Galvis and Meisel, 2010; Martínez, 2006; Franco and Raymond, 2009; Galvis *et al*., 2017; Galvis *et al*., 2021; Acosta and Bonet, 2022).

Decentralization in Colombia has long been regarded as a key strategy for reducing poverty and mitigating regional disparities. This process unfolds across three dimensions: political, fiscal, and administrative. Although the country has oscillated between periods of centralization and decentralization for more than a century, the current system traces its origins to the mid-1980s with political reforms introducing the popular election of mayors and governors. These changes were followed by fiscal decentralization, aimed at increasing the resources allocated to subnational governments through intergovernmental transfers. Subsequently, the definition of competencies and responsibilities for these governments marked the beginning of the modern era of Colombia's decentralization framework.

The institutionalization of the transfer system in Colombia dates back to Law 46 of 1971, which introduced two main transfer mechanisms: the "situado fiscal" for departments and special districts, and "participaciones municipales" for municipalities. These funds were primarily directed toward education, health, and basic water and sanitation services. Then,

there was a turning point in this trajectory with the 1991 Constitution, which sought to deepen decentralization by granting departments and municipalities new responsibilities alongside additional and growing financial resources (Bonet et al., 2020).

However, the economic downturn of the late 1990s, which reduced tax revenues and threatened the sustainability of education and health coverage, prompted a reform that introduced a new transfer system in 2002 (Sistema General de Participaciones, SGP). This system consolidated resources into a single pool of resources for municipalities and departments and decoupled transfers from national current revenues, linking them instead to inflation. Under this new arrangement, more than 85% of resources were earmarked for education, health, and basic sanitation, while the remainder was regionally allocated based on specific criteria: population size (municipalities with fewer than 50,000 inhabitants), indigenous reservations, and municipalities along the Magdalena River (Bonet et al., 2016). Despite the time elapsed since the implementation of these transfer schemes, only the first has been formally evaluated in Colombia.

The objective of this paper is to fill this gap by analyzing the effects of the regionally targeted transfers to Rio Magdalena's riverside municipalities. In particular, the purpose is to understand to what extent transfers to those particular regions affected socioeconomic indicators as well as the development and the well-being of the population. The main contribution to the literature is that, to the best of the authors' knowledge, this is the first time that causal effects of these transfers have been analyzed. So far, there is no information about how these resources have been used, and so the effectiveness of this type of transfer is unknown.

In order to answer these questions, I use a difference-in-differences approach within a yearly panel database for municipalities, covering the period 1994-2019, with the post reform period beginning in 2002. The identification strategy exploits the spatial distribution of the municipalities alongside the Magdalena River which receive extra transfers from the national government just for being located alongside the river. To identify the causal effects, the control group is made up of municipalities located alongside Cauca River, a similar stream sharing the same place of origin, as well as almost their entire course from south to north over its 1,350 kilometers. In this case our main assumption is that municipalities alongside the two rivers share similar socioeconomic characteristics but only Magdalena River riverside municipalities receive additional transfers.

The two most recent papers looking for effects of regionally targeted stimulus programs in Colombia are those of Galvis *et al*. (2019) and Yepes (2021). The former analyzed a tax incentive program called "Ley Páez", aimed at promoting new investments and the relocation of firms within the area where an earthquake took place. After analyzing the causal effects, the authors found no major impact either on the local public finances or on the quality of life as a result of the tax breaks. In the second paper, aimed at the analysis of the effects of transfers to municipalities under 25,000 inhabitants, the author found no evidence of improvement either on the GDP or on the various development indicators (Yepes, 2021).

The remaining of this study is organized as follows: Section 2 shows the importance of Magdalena River and presents the context of the transfers to its riverside municipalities. Section 3 describes the data used and presents the methodological approach. Section 4 analyses the main results of the causal effects of the extra transfers received by riverside

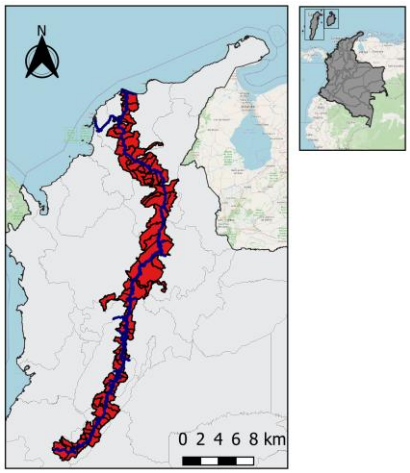
municipalities on socioeconomic indicators. Section 5 discusses the results, and Section 6 concludes.

2 The reform and its institutional context

With the deepening of decentralization following the 1991 Constitution, a series of regulations emerged to define the amounts, sources, and uses of resources allocated to subnational governments through intergovernmental transfers. One such regulation was Law 60 of 1993, which linked the growth of transfers to municipalities (municipal participation) to the nation's current revenues. Specifically, the law established progressively increasing percentages over time, starting at 23% in 1993 and reaching approximately 45% by 2001. The vast majority of these resources were earmarked for key sectors such as education, health, and basic sanitation. Within the remaining, 5% of the current national revenues was designated for municipalities with fewer than 50,000 inhabitants and 1.5% for municipalities located along the Magdalena River (distributed proportionally to their length of the riverbank).

This particular treatment for riverside municipalities was based on the Political Constitution of 1991 (Article 331), which stipulates that these territories shall receive special treatment in the participation of current revenues. There are 128 municipalities alongside the Magdalena River, but only 111 are certified to receive these special allowances, given that the others already receive different special territorial allowances. (Figure 1).

Figure 1. Magdalena River and its alongside municipalities

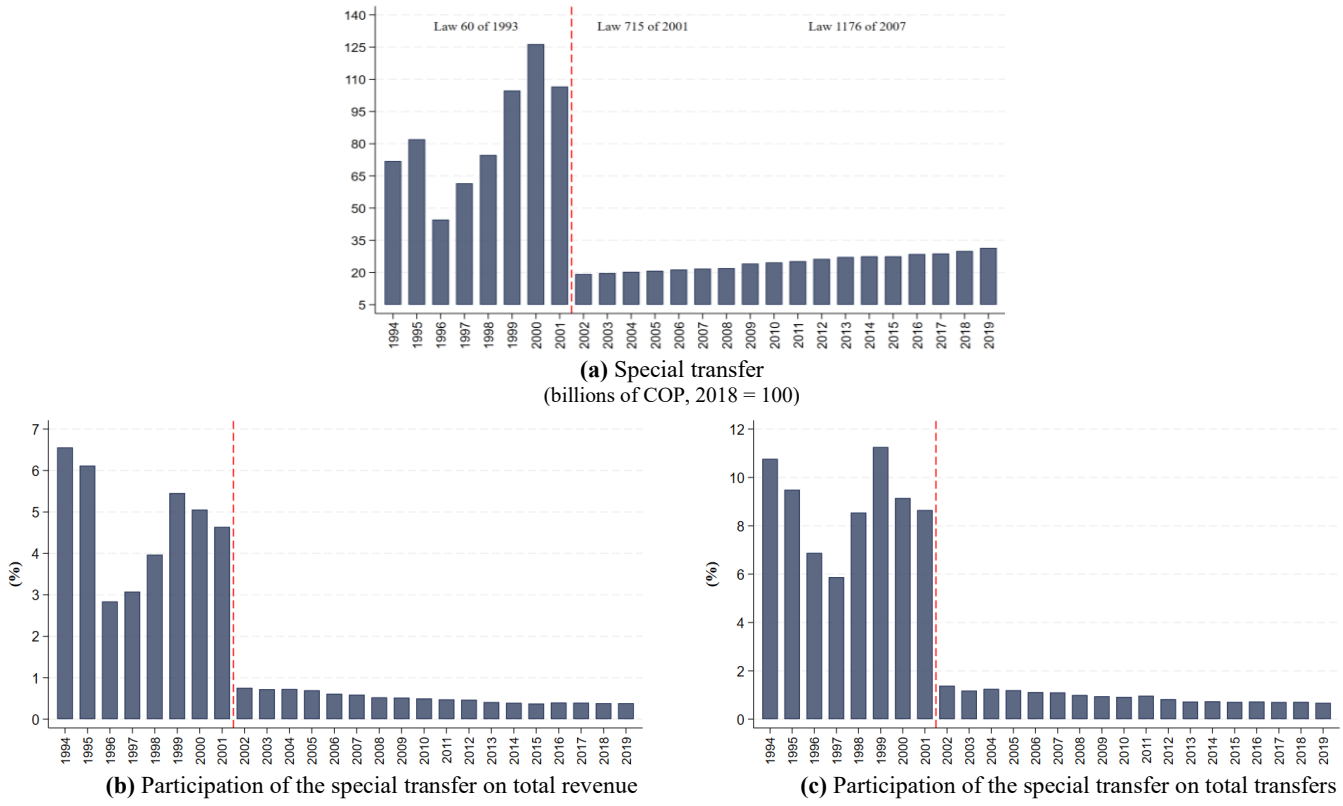


Source: Author 's elaboration.

At the beginning of 2002, with the enactment of Law 715 of 2001, a new transfer scheme was implemented, called the General System of Participations (SGP, by its acronyms in Spanish). This system decoupled transfers from the Nation's Current Revenues and introduced a new distribution framework in which 96% of SGP was allocated to sectoral transfers such health, education, basic sanitation, and general purposes, while the remaining 4% was reserved to special allocations. These special allocations targeted specific programs, including territorial pensions (2.9%), indigenous communities (0.52%), the school nutrition program (0.5%), and municipalities along the Magdalena River (0.08%).

For the municipalities under consideration, the focus of this study, the reform's implementation, represented a structural break in resource allocation. As illustrated in Figure 2, this allocation endured an abrupt and permanent decline, stabilizing at levels significantly lower than in the preceding period (Panel a).

Figure 2. Special transfer to riverside municipalities, 1994-2019



(a) Special transfer
(billions of COP, 2018 = 100)

(b) Participation of the special transfer on total revenue

(c) Participation of the special transfer on total transfers

Source: Author elaboration based on the National Planning Department data

These transfers declined from an average of 4.7% of total municipal revenues before 2001 to less than 1% thereafter (Panel b). Similarly, when compared to the total transfers received by riverside municipalities, their share fell from an average of 8.8% to below 2% (Panel c). An additional characteristic of these allocations is that the original legislation did not explicitly specify either their rationale or their intended use. It was not until the enactment of Law 1176 in 2007 that their purpose was briefly outlined, specifying that these resources should support projects related to reforestation, erosion control, wastewater treatment, and the restoration of the Magdalena River's navigability.

3 Data and empirical approach

3.1 Data

The National Planning Department (DNP) provides annual data on municipal public finances for the period 1994–2019. This dataset contains detailed information on current revenues, investment, and operating expenditures. Current revenues are disaggregated into tax revenues (property tax, corporate income tax and other taxes), non-tax revenues (such as fines and fees issued by municipalities), among others, as well as disposable transfers. Investment data comprise both gross capital formation and social investment; for the period 1994–2010, investment is further disaggregated by sector. This sectoral investment data is sourced from the Treasury and Public Information Consolidator (CHIP, by its acronym in Spanish) – Unique Territorial Form (FUT, by its acronym in Spanish)[1], covering sectors such as agricultural development and support for vulnerable groups. Operating expenditure includes personnel costs, general expenses, and paid transfers. All figures are expressed in millions of 2018 COP.

To proxy economic activity, I use nighttime lights (NTL) luminosity data from Li, Zhou, Zhao and Zhao (2020). The authors constructed an integrated and globally consistent NTL dataset by harmonizing intercalibrated NTL observations from the U.S. Air Force's Defense Meteorological Satellite Program (DMSP) with simulated DMSP-like observations derived from VIIRS data, which shows consistent temporal trends.

To measure forest loss, I use the Global Forest Change dataset developed by Hansen et al. (2013). Using more than 650,000 Landsat scenes at 30-meter resolution, the authors construct globally consistent maps of tree cover extent in 2000 and subsequent annual forest cover loss and gain over 2000–2012.

The low birth weight ratio and child mortality is calculated using microdata from vital statistics compiled by the National Administrative Department of Statistics (DANE).

Finally, for the specific case of the special transfer received by riverside municipalities, I rely on two sources of information: (i) documents from the Economic and Social National Political Council (CONPES, by its acronym in Spanish)[2] for the period of 1994 – 2001, and (ii) data from the DNP for the period 2002–2019.

[1] FUT is a financial balance sheet where public entities are required to report fiscal and financial information. This data is collected and processed by CHIP.
[2] CONPES is the central government´s main advisory body on socioeconomic development in Colombia.

Table 1. Pre-treatment outcomes by treatment status

Variable	All groups			Control group			Treatment group			Difference
	Obs.	Mean	Standard dev.	Obs.	Mean	Standard dev.	Obs.	Mean	Standard dev.	
Public goods										
Low Birth Weight Rate	704	64.2	24.0	320	67.1	19.9	384	61.8	26.7	5.3***
Child Mortality	1,408	13.3	9.4	640	13.8	8.2	768	12.9	10.3	0.9*
Night lights	1,405	9.5	7.0	637	9.6	5.7	768	9.4	7.9	0.1
Lost Forest Area	176	206.7	461.6	80	136.2	202.6	96	265.5	592.2	-129.3*
Investment										
Gross capital formation	1,272	8,359.9	41,785.1	613	10,420.1	57,249.2	659	6,443.4	17,793.4	3,976.7*
Social investment	1,243	7,281.5	38,816.6	599	7,647.5	41,791.4	644	6,941.2	35,858.4	706.3
Agricultural investment	1,352	184.8	307.5	630	169.2	242.9	722	198.5	354.1	-29.3*
Support for vulnerable groups	1,352	115.2	744.4	630	165.4	982.0	722	71.4	439.1	94**
Fiscal Variables										
Operating expenses	1,269	10,032.9	42,500.7	612	13,319.8	56,061.8	657	6,971.1	23,338.2	6,348.7***
Personnel expenses	1,264	4,847.9	20,925.4	609	6,485.1	27,928.5	655	3,325.6	10,754.5	3,159.4***
General expenses	1,268	2,610.1	11,465.7	612	3,417.5	15,243.8	656	1,856.8	6,029.6	1,560.7**
Paid transfers	1,229	2,680.6	13,704.5	593	3,559.5	17,371.8	636	1,861.1	8,970.3	1,698.4**
Disposable Current Revenue										
Tax Revenue	1,273	9,079.5	48,029.1	612	13,202.4	63,753.9	661	5,262.2	25,547.5	7,940.2***
Property Tax	1,270	3,443.8	18,485.4	612	5,405.0	25,078.2	658	1,619.7	8,259.3	3,785.3***
Industry and Commerce Tax	1,258	3,652.8	19,538.3	611	4,786.0	24,153.0	647	2,582.7	13,769.2	2,203.2**
Other Taxes	1,261	1,638.1	10,364.6	612	2,470.2	14,185.0	649	853.4	4,229.3	1,616.8***
Non-Tax Revenue	1,267	2,830.4	18,005.2	610	4,502.2	25,239.0	657	1,278.2	5,409.6	3224***
Disposable Transfers	1,213	920.2	3,680.9	574	811.8	2,750.1	639	1,017.7	4,350.4	-205.9

Notes: This table reports descriptive statistics for the outcome variables used in the analysis. Asterisks denote statistical significance at conventional levels: *** significant at the 1% level, ** at the 5% level, and * at the 10% level.

3.2 Empirical approach

To assess the potential impact of regionally targeted transfers on fiscal, investment, and economic indicators, I employ a difference-in-differences approach. This strategy exploits the exogenous change in transfer amounts resulting from the reform introduced in 2002 under the new transfers system, the SGP. The treatment group consists of municipalities receiving these special transfers, while the control group comprises municipalities located along the Cauca River, which is the second longest river in the country, running roughly parallel to the Magdalena for about 1,350 km (Pérez-Valbuena et al., 2015) (Figure 3). The identification assumption is that both groups share broadly similar socioeconomic characteristics due to their spatial distribution along comparable river systems, with the key distinction being that Cauca's riverside municipalities do not receive special transfers based on their location.

Figure 3. Treatment and control groups of municipalities
1st order Magdalena River vs 1st order Cauca River

Source: Author elaboration.

To evaluate whether the transfer reform influenced the socioeconomic conditions of municipalities along Magdalena River, I use the following main specification:

$$Y_{i,t} = \alpha_i + \delta_t + \gamma(RiverSide_i \times \mathbb{1}[t = \tau]) + X_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $Y_{i,t}$ denotes the outcome of interest in municipality i and year t; α_i represents municipality fixed effects, capturing time-invariant characteristics across municipalities; δ_t denotes year fixed effects, accounting for shocks and others reforms that may vary over time; and $X_{i,t}$ is a vector of control variables. Control variable selection follows the Post-Doble-Selection method proposed by Belloni *et al*. (2014a, 2014b), which employs LASSO-based techniques to identify relevant controls for both treatment and outcomes variables. The parameter of interest is then estimated using the union of these selected variables. This approach enables valid, robust, and often efficient inference in high-dimensional settings while mitigating model selection bias. The coefficient of interest, γ, captures the average difference in outcomes between municipalities along the Magdalena River and those along the Cauca River after the transfers system reform.

Additionally, because the identification of γ relies on the parallel trends assumption, meaning that in the absence of the reform outcomes for both groups of municipalities would have evolved similarly over time, I provide indirect evidence supporting this assumption by estimating an event-study specification. This approach examines whether the effect of receiving additional transfers varies relative to the baseline year 2001 across subsequent years. Specifically, the model estimates a coefficient for the Magdalena River riverside condition dummy variable every year, and the specification is as follows:

$$Y_{i,t} = \alpha_i + \delta_t + \sum_{\tau \neq 2001} \gamma_t \left(RiverSide_i \times \mathbb{1}[t = \tau]\right) + X_{i,t} + \varepsilon_{i,t}. \quad (2)$$

In Equation (2), the coefficients γ_t should be statistically indistinguishable from zero during the pre-reform period, which would support the parallel trends assumption. In the post-reform period, these coefficients capture the dynamic effects of the reform over time.

An important feature of the transfers allocated to municipalities along the Magdalena River is that the legislation specified that these allocations would not be uniform across municipalities but instead proportional to the length of the riverbank. This design feature provides an opportunity to examine the intensity of the treatment effect on various outcomes. For that purpose, and following Callaway et al. (2024), another specification is included in the analysis, which incorporates continuous treatment variables, allowing to determine how outcomes vary with the degree of exposure rather than mere treatment status. This approach enables a more precise assessment of the relationship between treatment intensity and the outcome variable, improving robustness by accounting for heterogeneous effects and strengthening the validity of causal inference. The specification for continuous treatment is as follows:

$$Y_{i,t} = \alpha_i + \delta_t + \gamma(Transfer_i \times \mathbb{1}[t = \tau]) + X_{i,t} + \varepsilon_{i,t} \quad (3)$$

In Equation (3) , $Transfer$ denotes the amount of special transfers received by each Magdalena River's riverside municipality, expressed in natural logarithm and measured in millions of 2018 COP. As it is a linear interaction model, the parameter of interest can be interpreted as the marginal effect of intensity after the reform.3 Furthermore, I estimate event-study specification for continuous treatment, as presented in Equation (4):

$$Y_{i,t} = \alpha_i + \delta_t + \sum_{\tau \neq 2001} \gamma_t \left(Transfer_i \times \mathbb{1}[t = \tau]\right) + X_{i,t} + \varepsilon_{i,t}. \quad (4)$$

Since I use a panel of data from 1994 to 2019 (in most outcomes variables), where serial correlation in the error term is likely to be a concern, I follow Bertrand et al. (2004) and implement their simple aggregation correction for differences-in-differences. Specifically, I collapse the dataset to two periods per municipality (pre- and post-treatment), computing the mean of the outcome and all control variables in each period, and then re-estimate the DiD specification on this two-period panel. This procedure treats the number of municipalities, rather than the total number of municipality–year observations, as the effective sample size, thereby mitigating the downward bias in standard errors induced by serially correlated shocks in long panels. The results of this robustness check are reported in Annex B.

[3] In this case the specification assumes linearity and homogeneity. The first meaning that each additional unit of intensity (one extra kilometer of riverbank or one additional COP of transfer) has the same marginal effect regardless of the starting level. Second, means that every municipality responds similarly to an additional unit of treatment intensity. These two assumptions facilitate the interpretation of the estimates, although may not hold in reality. If nonlinearity were assumed, it would imply that the first increments of intensity may have large impacts, while subsequent increments have diminishing returns. For the second assumption, non-homogeneity would mean that, for example, municipalities may react differently across different levels of rurality, or across different administrative capacities.

To maximize the number of periods available in the data, municipalities created after 1994 were excluded from both the treatment and control groups, thereby ensuring a balanced panel. Similarly, first-order neighboring municipalities belonging simultaneously to both groups were removed to mitigate potential spillover effects. As a result, of the 111 municipalities eligible to receive the special allocation (treatment group), 96 remain in the sample, while 80 of the 86 municipalities along the Cauca River (control group) are retained. The final sample comprises 176 municipalities observed over a 26-year period.

4 Results

Using a difference-in-differences framework, I analyze how social, economic and fiscal indicators respond to regionally focused transfers, specifically the special allocation granted to municipalities located along the Magdalena River in Colombia. The empirical strategy evaluates the effect of being a riverside municipality on key development outcomes, including child mortality, low birth weight, economic activity, investment, municipal fiscal performance and deforestation.

4.1 Baseline results, the role of being a riverside municipality on the Magdalena River

I begin by estimating Equation (1), where the treatment effect is identified through the interaction between a dummy variable for municipalities located along the Magdalena River and a post-reform indicator. This approach isolates the causal impact of the 2002 transfer reform, which substantially altered the fiscal landscape by reducing special allocations to riverside municipalities, from an average of 4.7% of total revenues before the reform to less than 1% thereafter. The first set of outcomes focuses on indicators related to quality of life and preventable health conditions, aiming to assess whether any portion of the special transfers was invested in projects intended to enhance well-being.

Table 2. Low birth and child mortality

Outcome	Low Birth Weight		Child Mortality	
Coefficient	0.0976	0.0976	0.1484	0.1357
	(0.0693)	(0.0692)	(0.1076)	(0.1079)
	[0.159]	[0.1589]	[0.1681]	[0.2086]
Average control group	78.2		9.8	
R-Squared	0.2625	0.2625	0.4218	0.4176
N	3,828	3,828	4,524	4,524
Controls	✓	✗	✓	✗
Period	1998-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table 2 reports the difference-in-differences estimates for two outcomes related to children's well-being: low birth weight and child mortality. Each outcome is evaluated under two specifications, one including the full set of controls and one excluding them. The estimated coefficients show the expected direction of the effect and remain consistent across specifications, suggesting that the 2002 reduction in special transfers is associated with increases in both low birth weight and child mortality. However, none of these estimates are statistically significant, indicating that no causal effect can be established. This lack of significance is not unexpected, given that the legislation did not specify any sectoral

allocation for these resources. In line with the country's decentralization framework, the health sector is already fully financed through a dedicated budget item. Consequently, municipalities have little incentive to allocate the special resources they receive for being located along the river to sectors that are already funded by other sources.

These findings motivate an exploration of broader outcomes under the hypothesis that the resources may have been directed to general activities with potential aggregate effects. To examine this, the second outcome analyzed is economic activity, proxied by municipal-level nighttime lights, a widely recognized measure of local economic performance. Table 3 presents the estimates, again under two specifications with and without the full set of controls. These results offer an initial assessment of how a major policy shift in intergovernmental transfers influenced overall regional development.

Table 3. Estimated effects of the 2002 transfers' reform on economic activity (night lights)

Outcome	Night Lights	
Coefficient	-0.0824	-0.0674
	(0.0254)	(0.0247)
	[0.0012]	[0.0064]
Average control group	10.2	
R-Squared	0.9574	0.9570
N	4,360	4,516
Controls	✓	✗
Period	1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

According to these results the coefficient, in both cases, is negative and statistically significant. Hence, the estimates reveal that, after the 2002 transfers reform, municipalities located along the Magdalena River reduced in average their economic activity between 6.7% and 8.2%. In substantive terms, after the deep fall in the amount of transfers received, the effect of the reform on the economic activity was the deterioration of the economic functioning in riverside municipalities. Evidence from recent studies suggests that transfers can positively influence subnational economic activity and GDP growth, particularly when designed to incentivize economic activities (Dougherty et al., 2025; Porto et al., 2025; Arachi et al., 2023). In Italy, for instance, formula-based grants introduced under the municipal equalization reform have been shown to enhance redistribution and support local economic performance (Arachi et al., 2023).

A second outcome closely linked to the overall economic functioning of local governments is investment. The data allow us to disaggregate investment into two main components, gross capital formation and social investment, often referred to as other investments. Also, for the total investment, sectoral disaggregation is available, enabling the identification of two additional outcomes particularly relevant to riverside municipalities, agriculture and support to vulnerable population (Table 4). The primary motivation for analyzing the causal effect of these resources on these two specific investment areas is twofold. First, the existing decentralization transfer system does not include a dedicated category for either of them, which means local authorities may be inclined to allocate part of the special transfers received by riverside municipalities to finance these programs according to their needs. Second, given

the rural conditions and vulnerability of populations located along the river, it is reasonable to assume that, since these special transfers lack earmarked purposes, mayors feel compelled to invest in improving agricultural activities and addressing the needs of vulnerable populations.

Table 4. Estimated effects of the 2002 transfers reform on investment

Outcome	Gross Capital Formation		Social Investment		Agricultural Investment		Support for Vulnerable Groups	
Coefficient	-0.0161	0.1404	-0.1032	-0.1044	-0.2672	-0.2136	-0.7092	-0.6015
	(0.0971)	(0.1027)	(0.0437)	(0.044)	(0.1147)	(0.1088)	(0.4053)	(0.3821)
	[0.8684]	[0.1714]	[0.0182]	[0.0175]	[0.0199]	[0.0497]	[0.0803]	[0.1155]
Average control group	16,782.9		37,887.4		257.6		509.1	
R-Squared	0.8576	0.8475	0.9243	0.9221	0.3831	0.3729	0.6680	0.6674
N	4,353	4,368	4,370	4,385	2,909	2,909	2,792	2,878
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2010		1994-2010	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

The results reveal two noteworthy findings. First, when examining the two main investment accounts, the estimates display the expected signs, with reductions in investment levels following the negative shock from the 2002 transfer reform. While gross capital formation is not statistically significant, other investment categories show significant declines of approximately 10% for riverside municipalities after the reform. Second, when disaggregating by sector, the reductions in investment in agricultural projects and assistance to vulnerable populations are striking. In these cases, the estimates are not only statistically significant but also substantial, indicating decreases of between 21% and 26% in agricultural investment and nearly 71% in support for vulnerable populations. This latter finding is particularly relevant given that municipalities located near water bodies, especially rivers, are spatially prone to natural disasters (Sánchez & Artunduaga, 2025; Ayala & Ospino, 2023; Cerón et al., 2022; WMO, 2021; Pérez et al., 2015; Galvis & Quintero, 2017).

The next set of results examines the fiscal impacts resulting from the sharp decline in special transfers to municipalities along the Magdalena River. These outcomes are grouped into three categories: operating expenditure, current revenues, and the main components of current revenues (Table **5**)

Table 5. Estimated effects of the 2002 transfers reform on fiscal outcomes

A. Operating expenditures

Outcome	Operating Expenses		Personnel Expenses		General Expenses		Paid Tranfers	
Coefficient	-0.1114	-0.1116	0.0159	0.0150	-0.0921	-0.0468	-0.6954	-0.6818
	(0.0207)	(0.0209)	(0.0738)	(0.0616)	(0.0788)	(0.0787)	(0.0646)	(0.0637)
	[0.00]	[0.00]	[0.8298]	[0.8075]	[0.2428]	[0.552]	[0.00]	[0.00]
Average control group	13,938.0		6,426.6		2,037.9		5,602.3	
R-Squared	0.9519	0.9496	0.9483	0.9435	0.8706	0.8685	0.7885	0.7876
N	4,406	4,414	4,207	4,364	4,358	4,366	4,271	4,279
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

B. Current revenues

Outcome	Disposable Current Revenue		Tax Revenue		Non-Tax Revenue		Disposable Transfers	
Coefficient	0.2884	0.2565	0.2216	0.3150	-0.2814	-0.2957	-0.0221	0.0107
	(0,0838)	(0,0787)	(0.0323)	(0.0304)	(0.0656)	(0.0611)	(0.0373)	(0.0381)
	[0,0006]	[0,0011]	[0.00]	[0.00]	[0.00]	[0.00]	[0.5537]	[0.7788]
Average control group	29,036.7		21,250.1		4,750.6		2,061.9	
R-Squared	0.9643	0.9585	0.9508	0.9476	0.7593	0.7551	0.6842	0.6279
N	4,042	4,188	4,413	4,413	4,201	4,349	4,295	4,295
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

C. Tax Revenues

Outcome	Property Tax		Industry and Commerce Tax		Other Taxes	
Coefficient	0.2371	0.2691	0.4334	0.4914	0.6064	0.6699
	(0.0754)	(0.0703)	(0.0445)	(0.0444)	(0.066)	(0.0635)
	[0.001]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
Average control group	8,351.8		7,162.5		3,587.3	
R-Squared	0.9570	0.9528	0.9253	0.9215	0.8441	0.8403
N	4,204	4,357	4,363	4,363	4,375	4,375
Controls	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

With respect to the effects on the first category of fiscal outcomes, operating expenditures, Panel A reports the estimates derived from Equation (1). The first column presents the aggregate operating expenditure for local governments, while the remaining columns disaggregate this total into its three principal components. A reduction in transfers from the national government would theoretically lead to a corresponding contraction in operating expenditures. It is noteworthy that the legislation establishing these special allocations for municipalities along the Magdalena River did not impose sectoral earmarks or specify activities for resource utilization. Consequently, in practice, these funds became part of the local governments' freely disposable current revenues.

Given the resource constraints faced by these municipalities, it was reasonable to anticipate that such allocations would primarily be directed toward covering operating costs. The estimates indicate that aggregate operating expenditures declined by approximately 11 percent, on average, following the reform for the group of municipalities located along the Magdalena River. The estimates of their components reveal no statistically significant effects for personnel or general expenditures; however, and as expected for the nature of this account, significant reductions are observed in the category of paid transfers. This latter category encompasses certain personnel-related costs, including supplementary payroll payments and transfers to entities contracted by local governments. These findings provide valuable insights into the allocation patterns of resources received by riverine municipalities under the revised fiscal framework.

The next step is to determine the relationship between riverside special transfers and the current revenues of municipal governments, particularly in the context of the sharp decline in revenues from this source. Panel B presents this set of results for the main account of

current revenues (Column 1) and for the aggregate of each of its components: tax revenues (Column 2), non-tax revenues (Column 3), and other current revenues (Column 4). The evidence indicates that, in the aggregate, the decline in transfers led to a significant increase in current revenues, ranging between 25% and 28%. At the component level, tax and non-tax revenues exhibit opposite directions of effect, positive for the former and negative for the latter. It is important to note that tax revenues represent by far the largest share of current revenues. From this perspective, the results reveal a positive response in tax revenues, which is a positive step in the right direction by municipalities toward recovering resources lost due to the reduction in transfers beginning in 2002.

A plausible hypothesis behind the reciprocal decline in non-tax revenues relates to the optimization of human and technical resources for tax collection. It is likely that the most efficient option was to strengthen capacity for collecting tax revenues at the expense of non-tax revenues. When examining the components of tax revenues (Panel C), the results show unequivocal increases across all three categories: property tax (Column 1), corporate income tax (Column 2), and other tax revenues (Column 3). These findings underscore resilience and an adaptive response that reflects local governments' efforts to mitigate resource losses. Another possible implication of the increase in tax revenues following a decline in transfer resources is the phenomenon of fiscal laziness. In this regard, recent literature on Colombia has found no aggregate evidence of fiscal laziness among municipalities (Bonet et al., 2018). However, the authors identify heterogeneity, noting that municipalities with lower income levels and smaller populations exhibited signs of fiscal laziness.

The discussion is also related to what is known as the flypaper effect, a phenomenon where the intergovernmental transfers tend to increase public spending at subnational level much more than an equivalent increase in local income would (Bradford and Oates, 1971; Courant et al., 1979). In other words, that subnational governments tend to behave differently in terms of public spending depending on whether they receive resources from transfers or from tax collection efforts. According to our results, the observed increase in tax revenues following a reduction in transfer resources suggests a counterpoint to the flypaper effect. While the flypaper hypothesis predicts that intergovernmental transfers "stick" to local spending more than equivalent local resources, these results indicate that municipalities actively compensated for declining transfers by strengthening tax collection capacity.

An additional outcome tested is deforestation. It is worth recalling that Law 60 of 1993, which established the special transfers for municipalities along the Magdalena River, did not initially specify the intended purpose of these resources, nor did the 2002 reform. It was only with a subsequent reform in 2007 (Law 1176) that a brief mention was made indicating that these funds should be allocated to projects related to reforestation, erosion control, wastewater treatment, and the restoration of the Magdalena River's navigability. Accordingly, and with the aim of assessing whether transfer resources were being used in any way to mitigate the lost forest after 2007 in riverside municipalities, Table 6 presents the results.

Table 6. Estimated effects of the 2002 transfers reform on deforestation

Outcome	Lost Forest Area	
Coefficient	-0.3168	-0.3054
	(0.3478)	(0.2799)
	[0.3624]	[0.2753]
Average control group	105.1	
R-Squared	0.8736	0.8669
N	3,173	3,306
Controls	✓	X
Period	2001-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

In this specific case, given that the announcement to the intended use of these resources occurred in 2007, that year is taken as the point of intervention, and the analysis covers the period 2001-2019. The results show that, although the direction of the effect aligns with expectations, the estimators for both specifications, with and without controls, are not statistically significant. Assuming the empirical design is properly specified, and the outcome variable is appropriate, a plausible explanation for the absence of significant reductions in forest area loss is that, since municipalities had already been receiving such resources for more than a decade, that created a budgetary dependence. It is because in the absence of clarity regarding the intended purpose of these funds, they may have allocated them to various sectors with different purposes. Furthermore, municipalities may not have perceived the legal reference as binding, and even if they were aware of the law and willing to comply, they would have needed to secure additional resources to meet pre-existing obligations. This situation was compounded by the fact that the 2002 reform had already substantially reduced the transfers received under this scheme.

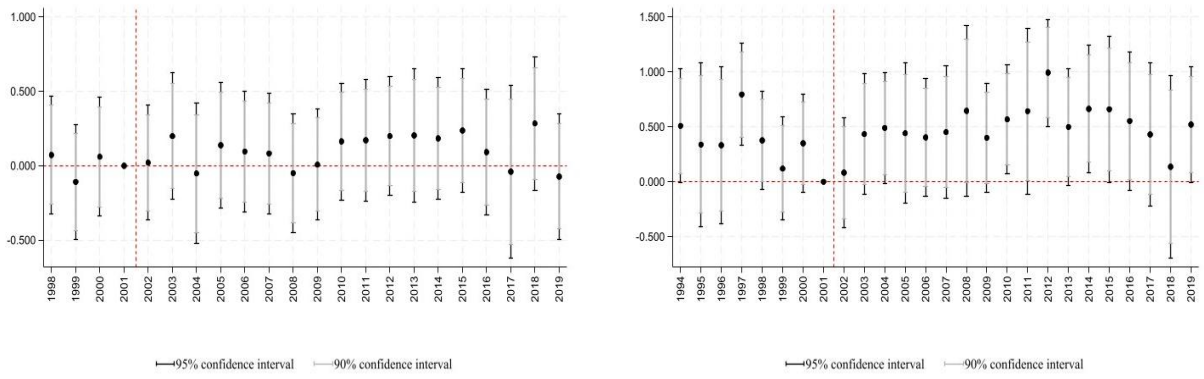
4.2 Dynamic effects of regionally focused transfers: an event-study approach

This section presents the results of Equation (2), which serves a dual purpose. First, it provides a useful framework for evaluating the key parallel trends assumption underlying Difference-in-Differences models. Under this assumption, in the absence of treatment, the treated and control groups would have experienced similar trends in the outcome variable over time, and consequently, the coefficients of interest should not be statistically significant prior to the reform. On the other hand, the coefficients should become statistically significant in the post-reform period if the transfer reform indeed influenced the outcomes. This assumption ensures that any divergence observed after the intervention can be attributed to the treatment rather than to pre-existing differences in trajectories.[4] A second purpose that can be derived from this type of models is to identify the dynamic effects of the transfer reform and to assess whether changes in the outcomes occurred immediately following the intervention or whether the effects materialized only after several periods.

[4] Violations of this assumption can lead to biased estimates, as they imply that the treated and control units were already on different paths before the intervention.

Figure 4 depicts the coefficients corresponding to Equation (2) for low-birth-weight rate and child mortality. As illustrated, they are not statistically significant before the reform providing the assumption of parallel trends for riverside municipalities of Magdalena River and Cauca River. The post-reform coefficients are not statistically significant for either of the two outcomes, which is consistent with the average post-reform effect estimated in the diff-in-diff models. This suggests that transfer resources do not appear to have been directed toward improving two of the most critical social indicators, particularly in economies that are highly rural and vulnerable to poverty.

Figure 4. Effect of 2002 transfers reform on low birth weight and child mortality: event-study analysis



(a) Low birth weight rate **(b)** Child mortality

Going further and analyzing an outcome that has a more general scope of the state of development of a local economy, Figure 5 presents the results for night lights, which reveals a clear pattern following the 2002 transfer reform. Prior to the intervention, the coefficients fluctuate around zero and are statistically insignificant, supporting the parallel trends assumption and suggesting no anticipatory effects. However, beginning in the years immediately after the reform, the estimates exhibit a persistent negative trajectory, with coefficients becoming increasingly negative and statistically significant from approximately 2006 onward. This indicates that the reduction in transfers was associated with a gradual and sustained decline in economic activity, rather than an abrupt shock. The magnitude of the effect deepens over time, reaching its lowest point toward the end of the observation period, which suggests long-term adverse consequences for local economies highly dependent on these fiscal resources.

Figure 5. Effect of 2002 transfers reform on the economic activity (night lights): event-study analysis

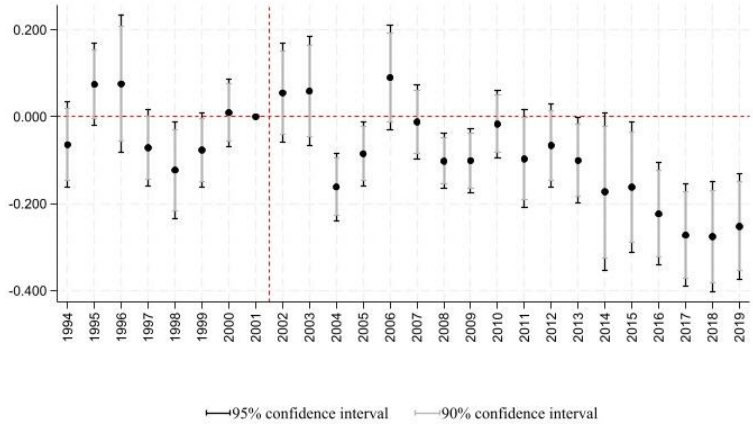
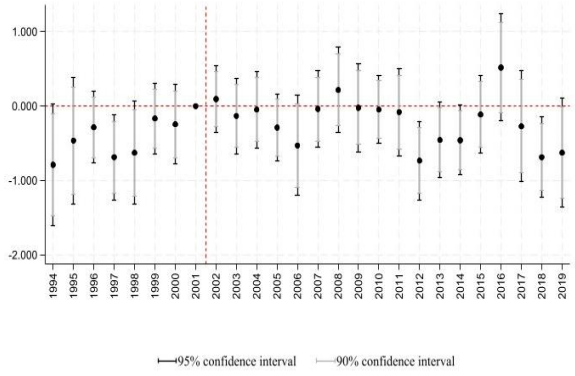
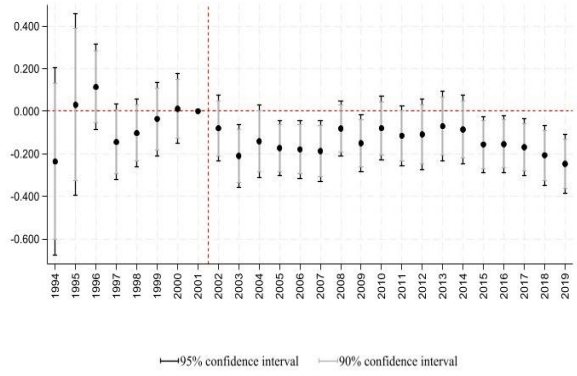


Figure 6 shows the results for the two main investments components: gross capital formation (panel a), and other investment, frequently reported as social investment (panel b). Also, this figure presents the estimates corresponding to investments related to two of the main sectors for municipalities with high rurality conditions, agriculture (panel c) and support to vulnerable population (panel d). The first two panels reveal contrasting dynamics. Gross capital formation fluctuates around zero before the intervention, suggesting no anticipatory effects, but also after the reform the coefficients mostly show confidence intervals including zero, meaning the effect is not statistically significant. Social investment, on the other hand, displays a clear downward trend post-intervention. While pre-event estimates hover near zero, the post-event coefficients become increasingly negative and mostly significant, indicating a clear reduction in social investment following the 2002 reform.

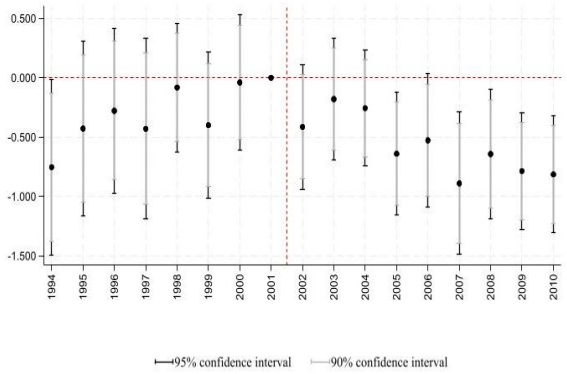
Figure 6. Effect of 2002 transfers reform on investments: event-study analysis



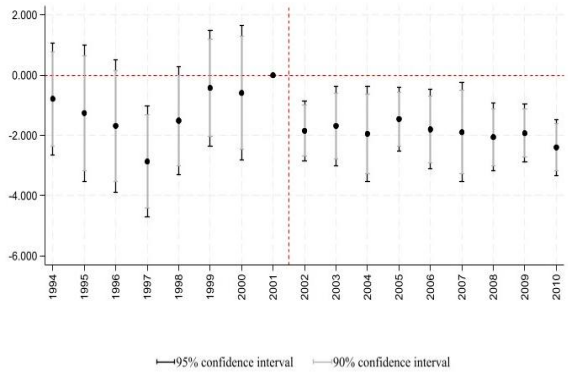
(a) Gross capital formation



(b) Social investment



(c) Agricultural investment

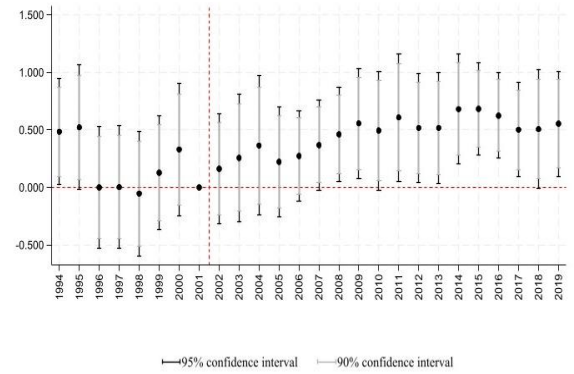


(d) Support for vulnerable groups

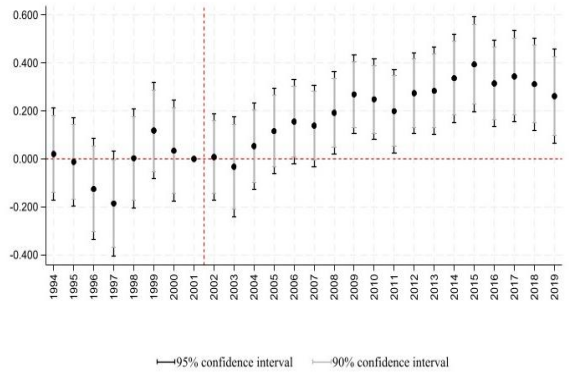
Agricultural investment and support for vulnerable groups, exhibit similar patterns. They both show no anticipatory patterns and clear post-reform coefficients falling below zero. Although both demonstrate a predominantly negative shift after the intervention, agricultural reaction appears to have been delayed for about three periods, after which the coefficients became increasingly negative. On the other hand, support to vulnerable population exhibited a clear-cut decrease just after the transfers reform in 2002. Overall, these patterns imply that reducing transfers constrained local governments' ability to finance socially oriented and sector-specific programs, disproportionately affecting vulnerable populations and rural development.

The next set of results are those related to current revenues. Figure 7 shows the dynamic effect after the intervention for current revenues and its main components. The first two panels, current revenues (panel a) and tax revenue (panel b), indicate that local governments adapted to the reduction in transfers by increasing their own revenue sources. The first outcome shows a clear upward trend after the intervention, with coefficients becoming increasingly positive. Similarly, tax revenue exhibits a gradual and sustained rise post-reform, with similar dynamics to the aggregation of the current revenue implying its role as the main driver of current revenues. In contrast, non-tax revenue (panel c) and disposable transfers (panel d) display different dynamics. While non-tax revenue exhibits a negative and stable effect during most of the post-reform period, disposable transfers show no significant effects in the short or long-run after the intervention. Overall, these results suggest that reductions in transfers, brough about by the reform, forced local governments to increase tax revenues, though non-tax sources did not play a compensatory role.

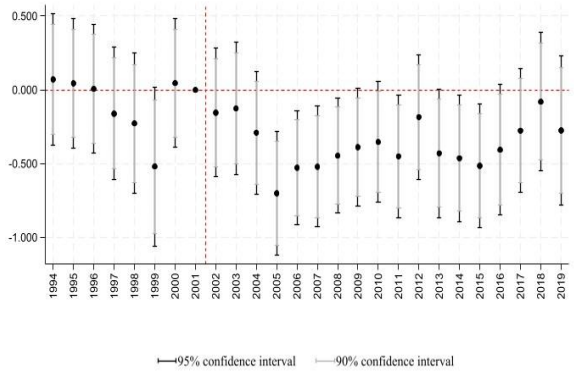
Figure 7. Effect of 2002 transfers reform on current revenues: event-study analysis



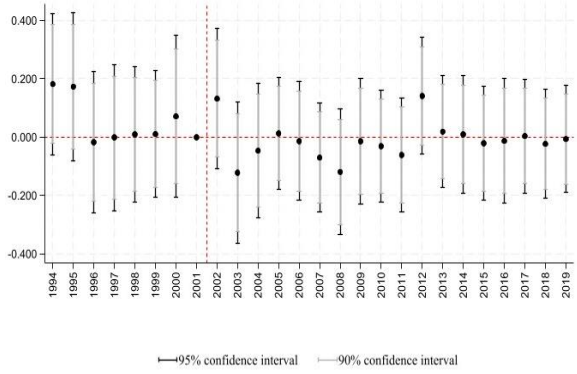
(a) Disposable current revenue



(b) Tax revenue



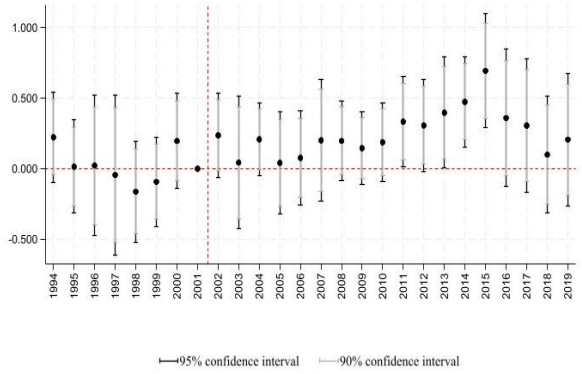
(c) Non-Tax revenue



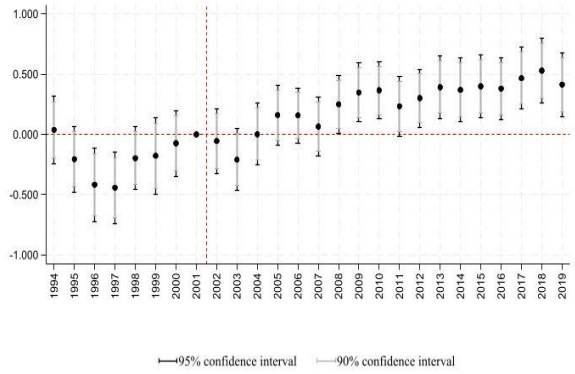
(d) Disposable transfers

Since one of the most evident and robust effects of the transfer reform, characterized by a strong and increasing pattern, occurred in aggregate tax revenues, Figure 8 explores the dynamic effects on each of its main components: property tax (panel a), corporate income tax (panel b), and other taxes (panel c). To contextualize their relative importance within total municipal tax revenues, the first two categories account for more than 90% of collections, with corporate income tax slightly exceeding property tax. The results are consistent with the average effects estimated earlier. What is particularly noteworthy is that, although all components exhibit a positive and growing trajectory over time, their adjustment dynamics differ. For instance, the category of other taxes provided the most immediate compensatory effect for municipal fiscal authorities, a predictable outcome given that these taxes are less technically and administratively demanding to implement in the short term. In contrast, measures involving property tax and corporate income tax are more complex and specialized, and therefore, their effects did not materialize immediately after the reform, nor even in the subsequent period, but rather required several periods before becoming evident.

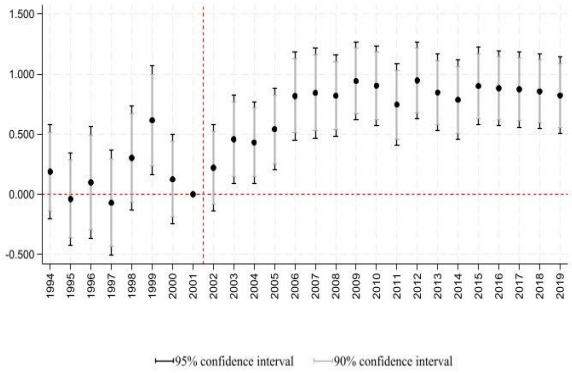
Figure 8. Effect of 2002 transfers reform on tax revenues: event-study analysis



(a) Property tax



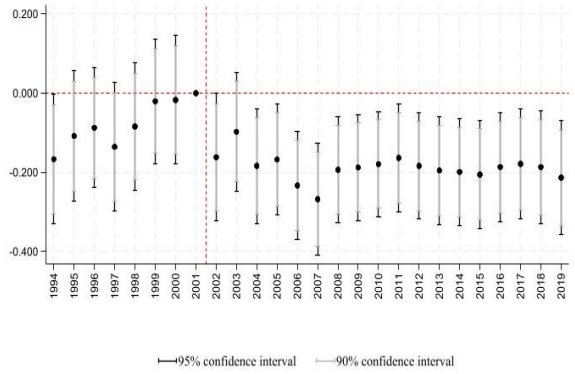
(b) Industry and commerce tax



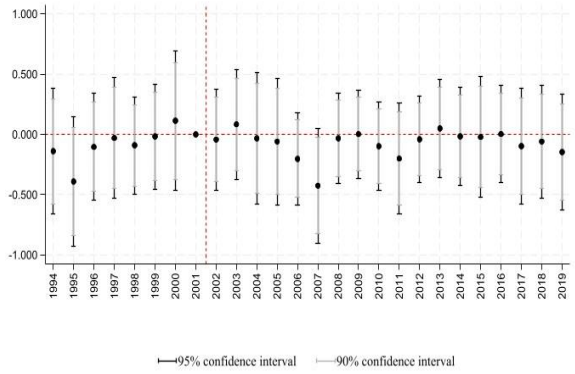
(c) Other taxes

For operating expenses, Figure 9 presents the aggregate results (panel a) and those for each of its components: personnel expenses (panel b), general expenses (panel c), and paid transfers (panel d). The first observation is that aggregate operating expenses declined almost immediately following the reduction in transfers. Although the decrease is clear and statistically significant across all periods, the effect remained stable over time. Examining the three components reveals that the main driver of this decline was paid transfers, which, despite minor fluctuations in some periods, remained consistently lower throughout the post-reform period. In contrast, there is no evidence of either immediate or delayed effects on personnel expenses or general expenses. This outcome is unsurprising, as these two categories are well known for their strong downward rigidity.

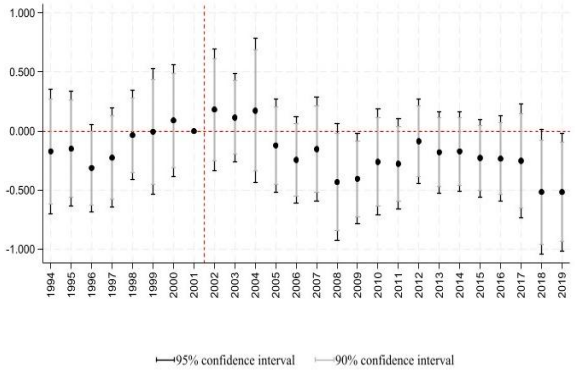
Figure 9. Effect of 2002 transfers reform on operating expenditures: event-study analysis



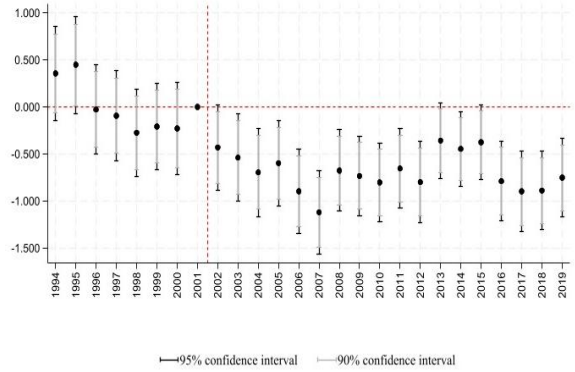
(a) Operating expenses



(b) Personnel expenses



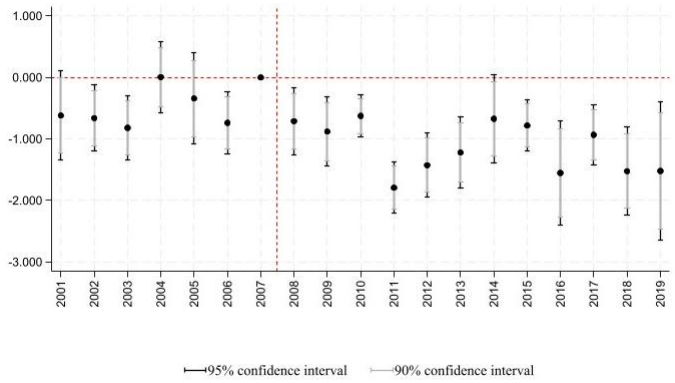
(c) General expenses



(d) Paid transfers

Lastly, Figure 10 illustrates the dynamic effects generated by the decline in transfers for municipalities along the Magdalena River. Unlike the previous outcomes analyzed, this estimation focuses on the impact of Law 1176 of 2007, which established for the first time that riverside municipalities should allocate the special transfers they receive to activities related to reforestation, erosion control, wastewater treatment, and the restoration of the river's navigability. The results reveal a generally negative trend across most periods; however, these findings are not conclusive for at least two reasons. First, the fundamental parallel trends assumption is violated, rendering the estimates invalid. Second, the results are inconsistent with those obtained from the difference-in-differences model, which found no significant effects of the law's announcement on the allocation of resources in the riverside municipalities of the Magdalena River.

Figure 10. Effect of 2002 transfers reform on deforestation: event-study analysis



These results contribute by showing the temporality of the effects and whether they were increasing, decreasing, or persistent over time. The 2002 transfer reform produced a clear and persistent contraction in social and sectoral investments, particularly in social programs, agricultural development, and support for vulnerable groups, while leaving gross capital formation largely unaffected. On the revenue side, municipalities responded by increasing tax revenues, especially through property and corporate income taxes, albeit with delayed effects due to their technical complexity. On the expenditure side, operating expenses fell immediately after the reform, driven mainly by reductions in paid transfers, whereas personnel and general expenses remained rigid, reflecting structural inflexibility in these categories.

These results support the fact that fiscal reforms that reduce intergovernmental transfers can trigger uneven adjustments. While local governments may strengthen tax collection over time, rigid expenditure structures and delayed revenue responses risk undermining social investment and equity goals. Hence, transfer reductions should be paired with capacity-building measures for tax administration and other mechanisms for critical social spending to prevent long-term adverse effects on vulnerable populations.

4.3 Exploring the intensity of the effect, a continuous treatment approach

Traditional difference-in-differences typically rely on a binary treatment indicator interacted with a post-reform dummy to estimate average treatment effects. However, many policy interventions exhibit heterogeneous exposure or "dosage," making the binary specification insufficient to capture the full range of causal responses. Recent methodological contributions emphasize the importance of incorporating continuous treatment variables to estimate intensity effects, which reflect how outcomes vary with the degree of exposure rather than mere treatment status. This approach allows researchers to uncover dose-response relationships and provides richer insights into policy effectiveness, particularly when reforms affect units unevenly across space or time (Callaway et al., 2024).

A distinctive feature of the transfers allocated to municipalities along the Magdalena River is that the law establishing them (Law 60 of 1993) stipulated that these transfers would not be uniform across all municipalities but rather proportional to the length of the riverbank. This characteristic enables an examination of the intensity of the effect on each outcome.

Furthermore, these results allow for an assessment of the robustness of the findings previously obtained using the discrete treatment variable.

In particular, I estimate Equation (3), where the parameter of interest corresponds to the interaction between the amount of transfers received by each municipality and the post-reform dummy variable. As it is a linear interaction model, the parameter of interest can be interpreted as the marginal effect of intensity after the reform, or in other words, it measures how much the outcome changes for each additional unit of intensity after the reform. It is important to mention that in this case the specification assume linearity and homogeneity.

The Appendix A shows the results for the whole set of outcomes. The first observation is that, overall, the results are consistent with those obtained using the model with a discrete treatment variable. Specifically, there is a negative and statistically significant effect on economic activity as measured by nighttime lights, as well as declines in aggregate investment other than gross capital formation, for which no significant effect was detected. Additionally, there are reductions in investment in two key sectors, agriculture and social assistance for vulnerable populations, particularly in this set of riverbank municipalities characterized by higher relative rurality and greater exposure to natural disasters.

Regarding public finances, the reduction in transfers resulting from the 2002 reform translated into a significant decline in aggregate operating expenditures, seemingly driven by paid transfers. With regard to current revenues, the compensatory pattern noted in the previous subsection persists, with an increase in total current revenues primarily led by tax and non-tax revenues. Within tax revenues, both property tax and corporate income tax exhibit positive and statistically significant effects. Lastly, regarding deforestation, as in the categorical treatment specification, although showing the expected negative estimate it was not statistically significant.

5. Discussion

The results of this study provide important insights into the effectiveness of regionally targeted transfers within the broader context of decentralization policies. Decentralization has long been promoted as a mechanism to improve governance and reduce regional disparities by granting subnational governments greater autonomy and resources (Besley & Coate, 2003; Faguet, 2004; Bergvall et al., 2006; Brosio & Jimenez, 2012). In Colombia, the 1991 constitutional reform deepened this process, aiming to address persistent inequalities and improve access to essential public goods (Bonet et al., 2020). However, our findings suggest that the special transfers allocated to Magdalena River municipalities did not produce measurable improvements in social indicators such as child mortality or low birth weight, echoing previous evidence that decentralization alone does not guarantee better welfare outcomes (Del Valle & Galindo, 2010; Yepes, 2021).

In contrast, the economic and fiscal dimensions reveal significant effects. The reduction in transfers after the 2002 reform led to a contraction in local economic activity and a decline in municipal investment, confirming the vulnerability of disadvantaged regions to fiscal shocks. These results are consistent with the literature on regional disparities, which emphasizes the structural constraints faced by lagging regions despite targeted interventions (Pike et al., 2010; McCann, 2020; Bonet et al., 2023). Interestingly, municipalities

demonstrated resilience by increasing tax revenues, an adaptive response that reflects local governments' efforts to mitigate resource losses. Nonetheless, these compensatory measures were insufficient to prevent the slowdown in economic performance, reinforcing the argument that fiscal autonomy in structurally weak regions has limited capacity to offset reductions in intergovernmental transfers (Faguet, 2004; Brosio & Jimenez, 2012).

Another critical finding concerns the 2007 legislation that earmarked these special transfers to Magdalena River riverside municipalities for environmental and navigability projects, including reforestation, erosion control, wastewater treatment, and river restoration. Despite these explicit mandates, there is no evidence that resources were effectively allocated to these purposes since there is no evidence of reduction in deforestation. This outcome highlights governance and enforcement weaknesses, as well as competing priorities at the municipal level, which diverted funds toward other needs. Similar challenges have been documented in other regionally targeted programs, where the absence of robust monitoring and accountability mechanisms undermines policy effectiveness (Oakley & Tsao, 2006; Accetturo & De Blasio, 2012). The ambiguity in the initial design of the transfer system, where resources were not conditioned to specific actions, likely exacerbated this problem, allowing municipalities to allocate funds in ways inconsistent with long-term sustainability goals.

These findings have broader implications for the debate on decentralization and regional development. While the rationale behind decentralization and targeted transfers is grounded in reducing disparities and improving welfare, the Colombian experience analyzed here suggests that design flaws and weak institutional capacity can significantly limit their impact. The lack of observable improvements in social indicators, combined with economic deterioration and misallocation of resources, underscores the need for complementary measures beyond financial transfers. These include clearer sectoral guidelines, stronger enforcement mechanisms, and capacity-building initiatives to ensure that local governments can effectively manage resources and deliver on policy objectives.

Finally, the evidence presented here aligns with recent studies questioning the effectiveness of regionally targeted programs in Colombia with limited or no impact on local development indicators (Galvis et al., 2019; Yepes, 2021). Taken together, these results call for a rethinking of regional policy design, emphasizing integrated approaches that combine fiscal transfers with institutional strengthening and rigorous monitoring frameworks (Bonet et al., 2020; Ome and Pérez, 2022). Without these elements, decentralization risks becoming a formal exercise with limited substantive effects on reducing disparities and improving the quality of life in disadvantaged communities.

6 Conclusions

This study contributes to the literature on decentralization and regionally targeted transfers by providing the first causal evidence on the effects of special transfers to municipalities along the Magdalena River in Colombia, representing, to the best of my knowledge, the first empirical analysis of this kind. Although the transfers object of this study were targeted to municipalities along the Magdalena River, the absence of clear guidelines regarding their purpose or sectoral allocation created uncertainty about how these resources were actually

used. After examining a range of social, economic, and fiscal outcomes, the evidence suggests that only indicators related to the economic and fiscal performance of municipalities were significantly affected.

On these fronts, the results indicate a deterioration in local economic activity and a decline in municipal investment following the 2002 reform that reduced transfers. These findings highlight the vulnerability of riverside municipalities to fiscal shocks and their dependence on intergovernmental transfers for sustaining development. At the same time, the observed increase in tax revenues demonstrates a degree of resilience and adaptive capacity among local governments, which sought to compensate for the loss of resources through enhanced revenue collection.

The analysis also reveals that the 2007 legislation mandating the use of special transfers for environmental and navigability projects did not translate into effective implementation. This points to weaknesses in governance and enforcement mechanisms, as well as competing priorities that diverted resources away from their intended purposes. From a policy perspective, these results underscore the need for a more comprehensive approach to regional development that goes beyond the allocation of financial resources. Future interventions should incorporate clearer guidelines for resource use, and capacity-building initiatives to ensure that transfers are effectively translated into improvements in welfare. Additionally, further research is needed to explore the long-term consequences of these fiscal reforms on regional disparities and to identify complementary policies that can enhance the resilience and development prospects of disadvantaged communities.

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Appendix A: Causal effects for continuous variable treatment

Table A. 1. Low birth and child mortality

Outcome	Low Birth Weight Rate		Child Mortality	
Coefficient	-0.0102	-0.0102	0.0025	-0.0011
	(0.015)	(0.015)	(0.018)	(0.0181)
	[0.4963]	[0.4963]	[0.8902]	[0.9508]
Average control group	78.2		9.8	
R-Squared	0.2625	0.2625	0.4217	0.4175
N	3,828	3,828	4,524	4,524
Controls	✓	✗	✓	✗
Period	1998-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 2. Economic activity (night lights)

Outcome	Night Lights	
Coefficient	-0.0176	-0.0147
	(0.0038)	(0.0036)
	[0.00]	[0.0001]
Average control group	10.2	
R-Squared	0.9576	0.9572
N	4,360	4,516
Controls	✓	✗
Period	1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 3. Investment

Outcome	Gross Capital Formation		Social Investment		Agricultural Investment		Support for Vulnerable Groups	
Coefficient	0.0243	0.0154	-0.0233	-0.0249	-0.0544	-0.0432	-0.1236	-0.1054
	(0.0163)	(0.015)	(0.0082)	(0.0083)	(0.0227)	(0.0213)	(0.0591)	(0.0555)
	[0.1358]	[0.3036]	[0.0047]	[0.0027]	[0.0165]	[0.0432]	[0.0365]	[0.0574]
Average control group	16,782.9		37,887.4		257.6		509.1	
R-Squared	0.8529	0.8475	0.9244	0.9222	0.3832	0.3730	0.6682	0.6676
N	4,209	4,368	4,370	4,385	2,909	2,909	2,792	2,878
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2010		1994-2010	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 4. Operating expenditure

Outcome	Operating Expenses		Personnel Expenses		General Expenses		Paid Tranfers	
Coefficient	-0.0228	-0.0226	0.0041	-0.0011	-0.0128	-0.0047	-0.1236	-0.1201
	(0.0039)	(0.0039)	(0.0112)	(0.0097)	(0.0122)	(0.0121)	(0.0122)	(0.012)
	[0.00]	[0.00]	[0.7149]	[0.9086]	[0.2936]	[0.7003]	[0.00]	[0.00]
Average control group	13,851.2		6,426.6		2,037.9		5,602.3	
R-Squared	0.9520	0.9497	0.9483	0.9435	0.8706	0.8684	0.7875	0.7865
N	4,406	4,414	4,207	4,364	4,358	4,366	4,271	4,279
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 5. Municipal Revenues and Transfers

Outcome	Disposable Current Revenue		Tax Revenue		Non-Tax Revenue		Disposable Transfers	
Coefficient	0.0269	0.0234	0.0438	0.0618	-0.0579	-0.0595	-0.0459	-0.1234
	(0,0125)	(0,0118)	(0.0063)	(0.006)	(0.0126)	(0.0117)	(0.0314)	(0.0273)
	[0,0313]	[0,0474]	[0.00]	[0.00]	[0.00]	[0.00]	[0.1449]	[0.00]
Average control group	29,036.7		21,250.1		4,750.6		2,061.9	
R-Squared	0.9641	0.9584	0.9509	0.9477	0.7595	0.7553	0.6851	0.6126
N	4,085	4,231	4,413	4,413	4,201	4,349	4,295	4,295
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 6. Municipal Tax Revenues

Outcome	Property Tax		Industry and Commerce Tax		Other Taxes	
Coefficient	0.0359	0.0435	0.0435	0.0795	0.1198	0.1344
	(0.012)	(0.011)	(0.0087)	(0.0087)	(0.0121)	(0.0122)
	[0.0028]	[0.0001]	[0.00]	[0.00]	[0.00]	[0.00]
Average control group	8,351.8		7,162.5		3,587.3	
R-Squared	0.9570	0.9528	0.9122	0.9081	0.8484	0.8409
N	4,204	4,357	2,321	2,321	4,375	4,375
Controls	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019	

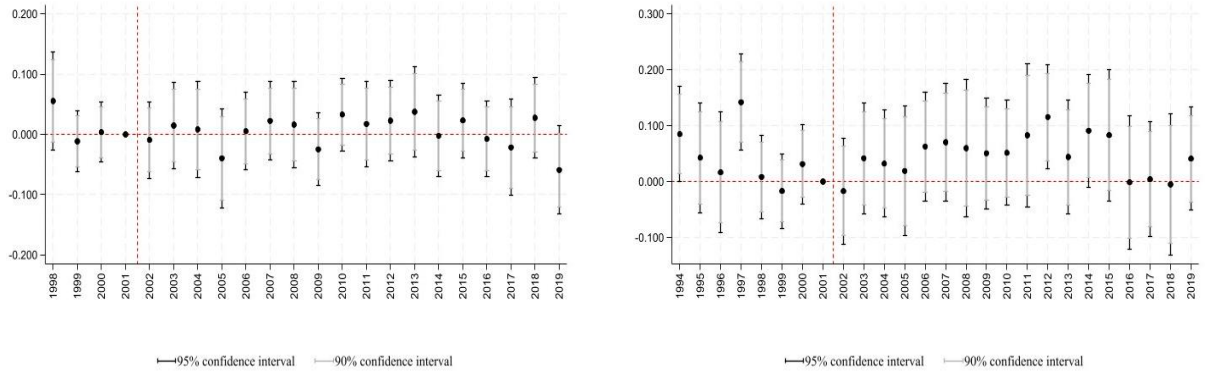
Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Table A. 7. Lost forest

Outcome	Lost Forest Area	
Coefficient	-0.0615	-0.0696
	(0.0528)	(0.0423)
	[0.2441]	[0.0997]
Average control group	105.1	
R-Squared	0.8783	0.8670
N	3,173	3,306
Controls	✓	✗
Period	2001-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log. 3) Municipalities and years Fix Effect.

Figure A. 1. Effect of 2002 transfers reform on low birth weight and child mortality: event-study analysis – Continuous treatment effects



(a) Low birth weight rate **(b)** Child mortality

Figure A. 2. Effect of 2002 transfers reform on economic activity (night lights): event-study analysis – Continuous

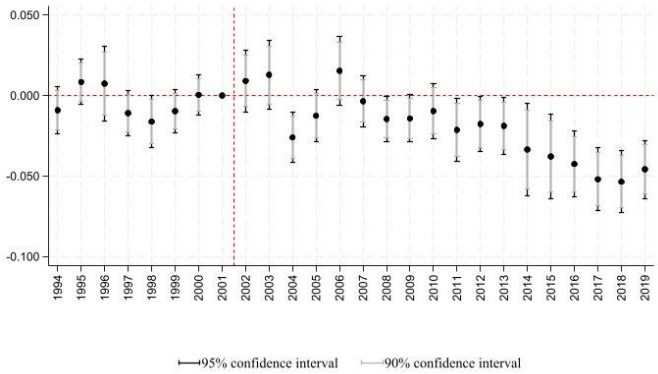
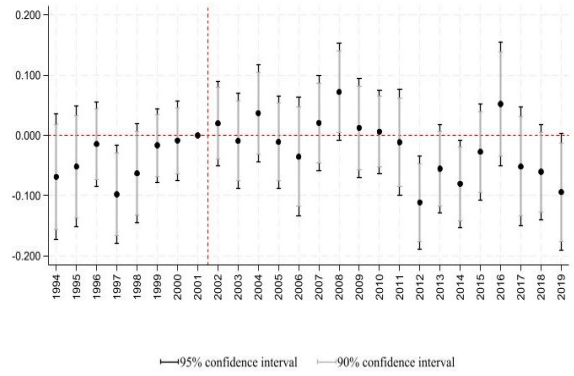
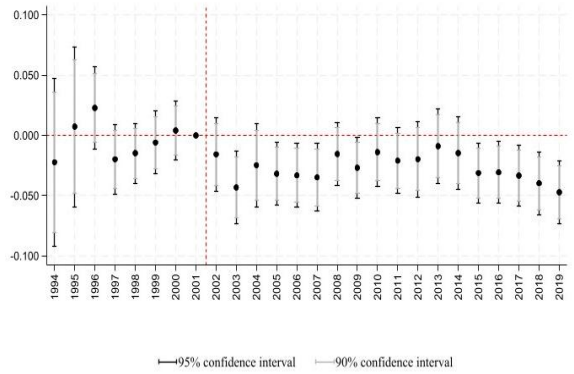


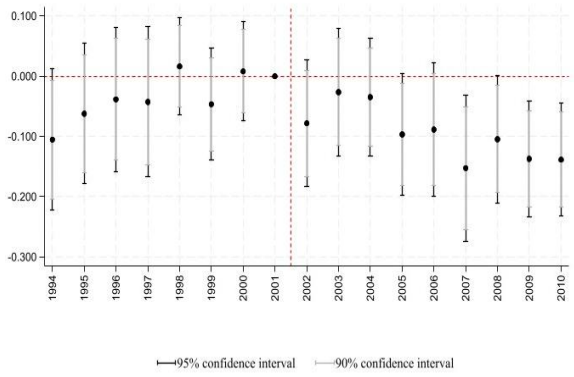
Figure A. 3. Effect of 2002 transfers reform on investment: event-study analysis – Continuous treatment effects



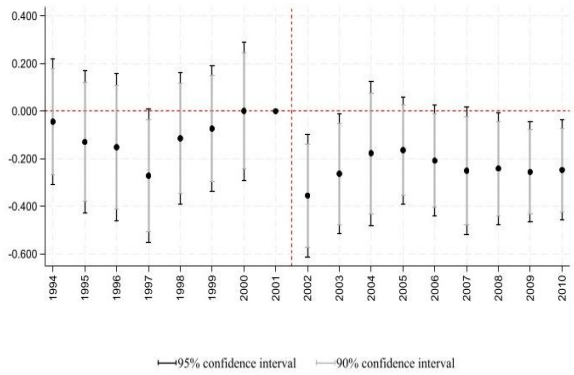
(a) Gross capital formation



(b) Social investment

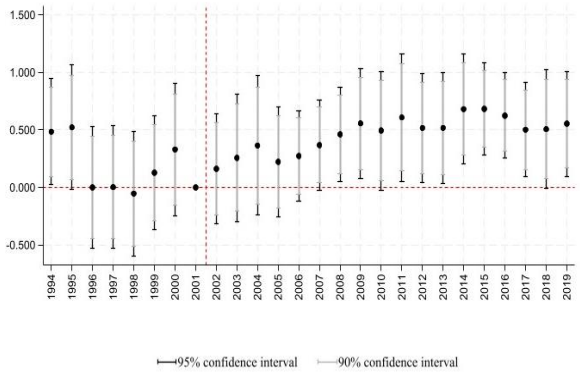


(c) Agricultural investment

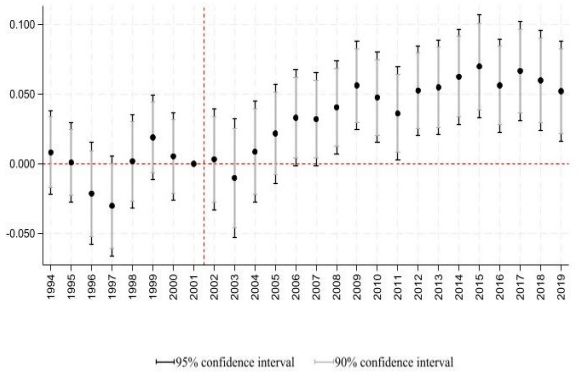


(d) Support for vulnerable groups

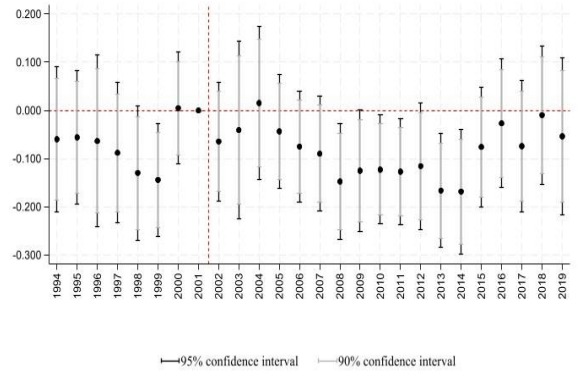
Figure A. 4. Effect of 2002 transfers reform on current revenues: event-study analysis – Continuous treatment effects



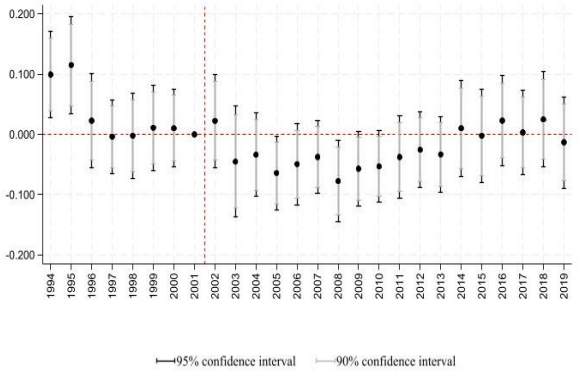
(a) Disposable current revenue



(b) Tax revenue

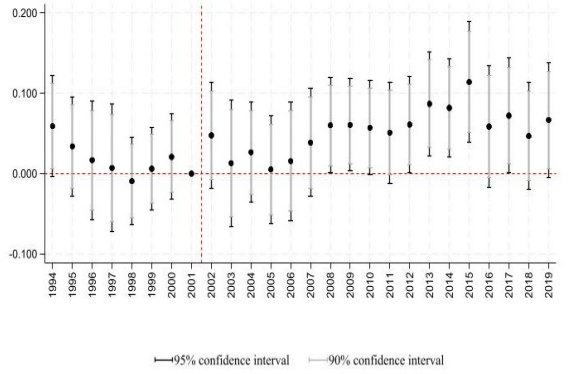


(c) Non-Tax revenue

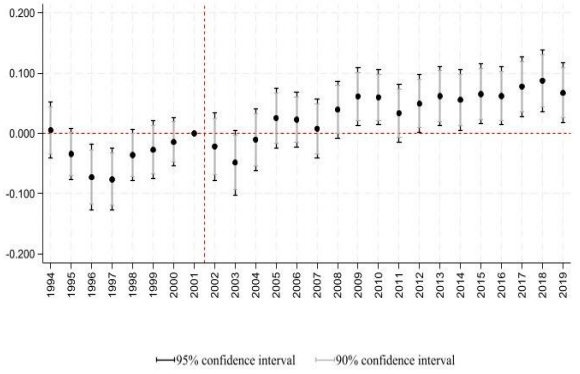


(d) Disposable transfers

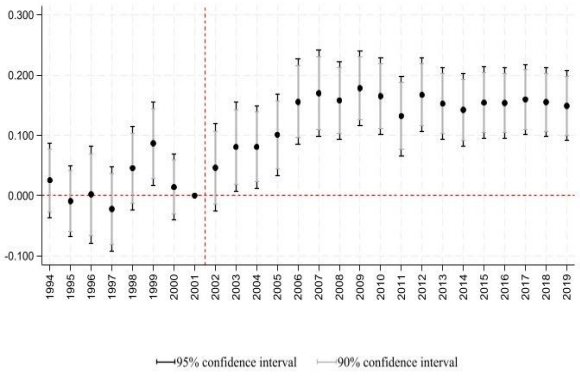
Figure A. 5. Effect of 2002 transfers reform on tax revenues: event-study analysis – Continuous treatment effects



(a) Property tax

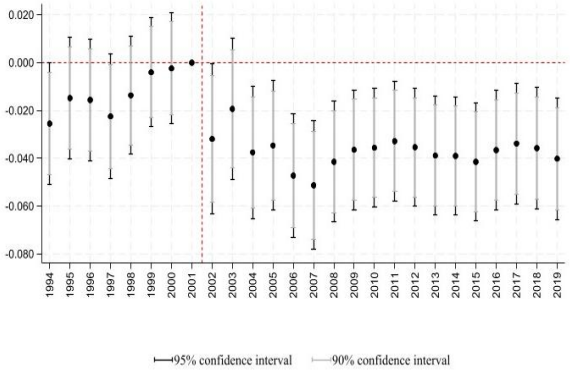


(b) Industry and commerce tax

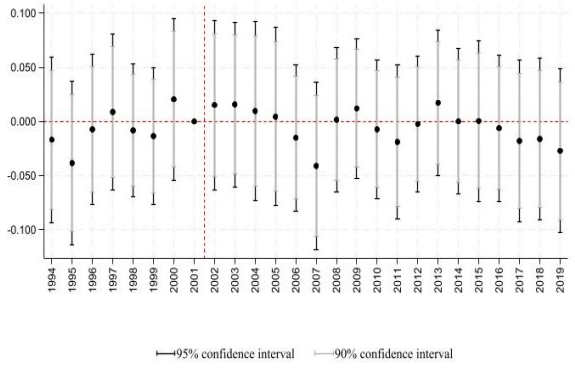


(c) Other taxes

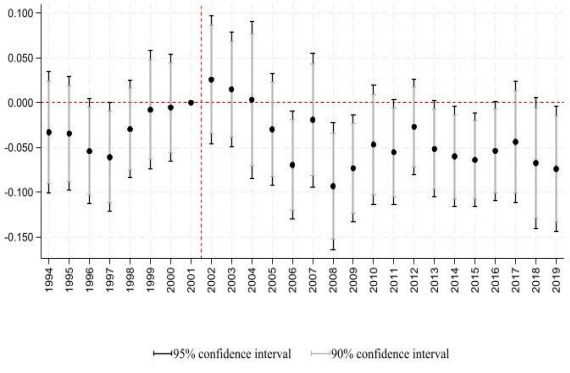
Figure A. 6. Effect of 2002 transfers reform on operating expenses: event-study analysis – Continuous treatment effects



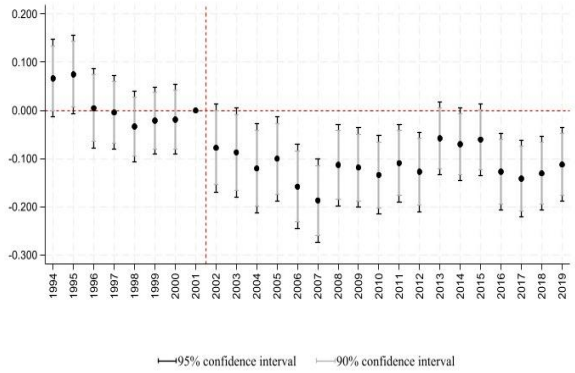
(a) Operating expenses



(b) Personnel expenses



(c) General expenses



(d) Paid transfers

Apendix B: Robustness to Serial Correlation: Simple Aggregation

Table B. 1. Low birth and child mortality

Outcome	Low Birth Weight		Child Mortality	
Coefficient	0.0976	0.0976	0.1484	0.1357
	(0.0726)	(0.0726)	(0.1197)	(0.1337)
	[0.1808]	[0.1808]	[0.217]	[0.3115]
R-Squared	0.7656	0.7656	0.8914	0.8874
N	348	348	348	348
Controls	✓	✗	✓	✗
Period	1998-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 2. Economic activity (night lights)

Outcome	Night Lights	
Coefficient	-0.0739	-0.0674
	(0.0454)	(0.0444)
	[0.1052]	[0.1311]
R-Squared	0.9900	0.9899
N	346	348
Controls	✓	✗
Period	1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 3. Investment

Outcome	Gross Capital Formation		Social Investment		Agricultural Investment		Support for Vulnerable Groups	
Coefficient	0.0571	0.1096	-0.0070	-0.0574	-0.2657	-0.1773	0.4187	0.4400
	(0.1751)	(0.1861)	(0.0895)	(0.0934)	(0.1663)	(0.1693)	(0.1895)	(0.1916)
	[0.7447]	[0.5567]	[0.9377]	[0.5399]	[0.1119]	[0.2964]	[0.0284]	[0.0229]
R-Squared	0.976	0.971	0.958	0.949	0.757	0.754	0.906	0.903
N	346	348	350	352	352	352	350	352
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2010		1994-2010	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 4. Operating expenditure

Outcome	Operating Expenses		Personnel Expenses		General Expenses		Paid Transfers	
Coefficient	-0.1132	-0.1164	0.0307	0.0254	-0.0500	-0.0376	-0.6616	-0.6412
	(0.0399)	(0.0402)	(0.1753)	(0.1221)	(0.1144)	(0.1127)	(0.1034)	(0.0984)
	[0.0051]	[0.0043]	[0.8613]	[0.8356]	[0.6629]	[0.7395]	[0.00]	[0.00]
R-Squared	0.987	0.985	0.983	0.981	0.971	0.969	0.949	0.949
N	350	350	334	346	346	346	348	348
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 5. Municipal Revenues and Transfers

Outcome	Disposable Current Revenue		Tax Revenue		Non-Tax Revenue		Disposable Transfers	
Coefficient	0.2664	0.2623	0.2054	0.3199	-0.2811	-0.3004	-0.0597	0.0638
	(0.1731)	(0.1565)	(0.0755)	(0.0667)	(0.1092)	(0.1079)	(0.0839)	(0.0942)
	[0.126]	[0.0958]	[0.0072]	[0]	[0.0109]	[0.006]	[0.4782]	[0.4991]
R-Squared	0.988	0.985	0.987	0.986	0.948	0.947	0.820	0.773
N	334	346	350	350	338	350	350	350
Controls	✓	✗	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 6. Municipal Tax Revenues

Outcome	Property Tax		Industry and Commerce Tax		Other Taxes	
Coefficient	0.2353	0.2626	0.4853	0.5364	0.6526	0.7236
	(0.1519)	(0.1465)	(0.1084)	(0.1025)	(0.1168)	(0.1205)
	[0.1234]	[0.0749]	[0.00]	[0.00]	[0.00]	[0.00]
R-Squared	0.990	0.989	0.977	0.976	0.959	0.955
N	334	346	350	350	350	350
Controls	✓	✗	✓	✗	✓	✗
Period	1994-2019		1994-2019		1994-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Table B. 7. Lost forest

Outcome	Lost Forest Area	
Coefficient	-0.7203	-0.7509
	(0.272)	(0.2125)
	[0.009]	[0.0005]
R-Squared	0.9743	0.9734
N	334	348
Controls	✓	✗
Period	2001-2019	

Note: 1) Robust standard errors in parenthesis and p-values in brackets. 2) All outcomes are in log.

Appendix C: Aditional figures, illustration and tables

Ilustration C. 1. Timeline of transfer scheme in Colombia