

Innovative Public Transportation Policy Causes Local-Level Retrospective Voting¹

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Introduction

Does policy innovation cause retrospective voting? Voters often reward politicians for successful policymaking (Burnett & Kogan, 2017; Fiorina, 1978; Healy & Malhotra, 2013; Hopkins & Pettingill, 2018). However, they may fail to do so if their perceptions are biased by partisan preferences (Healy et al., 2017; Sigelman et al., 1991) and they cannot clearly identify who was responsible for the policy design and implementation (Jilke, 2018). These barriers pose a challenge to politicians who want to engage in policy innovation. Beyond the risk of failing to improve voters' life conditions, incumbents may not be rewarded for successful policymaking (Hong et al., 2022; Mullin & Hansen, 2023).

In this paper, we propose three innovations to answer this research question. First, rather than considering national-level economic policy as traditional studies of retrospective voting often do (e.g., Fiorina, 1978), we follow Burnett and Kogan (2017) by focusing on local-level transportation issues. These authors investigated the electoral returns of road quality (e.g., potholes) in American cities. Here, we investigate the implementation of a major innovation in public transportation in the developing world. Our policy of choice (the Bilhete Único of São Paulo, Brazil) introduced, among other improvements, a smart card that replaced cash payments. With this solution, the municipality of São Paulo allowed millions of voters (mostly working-class individuals) to use multiple buses at the cost of one trip when commuting to work, school,

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or leisure. This automated fare collection system for integrated ticketing drastically reduced the time spent in public transportation, as well as users' costs.

Second, instead of focusing on entire electoral districts (e.g., Burnett & Kogan, 2017; Hopkins & Pettingill, 2018), we use georeferencing tools to compare the electoral outcomes of policy innovation in different regions of the same municipality. More specifically, we identify the number of beneficiaries in each neighborhood of São Paulo and how many votes the incumbent obtained in each of them in the elections before and after the policy implementation. We are, then, able to causally infer that retrospective voting occurred predominantly in the neighborhoods with the most smart-card users, compared both to other neighborhoods (with fewer beneficiaries) and the same neighborhoods in the previous election.

Third, we demonstrate that these effects go beyond the traditional outcomes of pork-barreling policies. Public transportation reforms often consider economic, technical, and political aspects (Yoo & Lee, 2023). It attempts to reduce operational costs (and the costs to users), shorten commuting time and reduce traffic, and improve performance standards that were set also considering the incumbent's and the bureaucracy's preferences. Given the multiple stakes at play in major urban cities, it is harder to use public transportation as a pork barrel tool if compared to other policy sectors. Our models, thus, account for other policies implemented by the same administration with clearer vote-grabbing intentions. We verify that, despite the technical motivations of *Bilhete Único*, its causal effects remain robust after this and other sensitivity tests.

Public Transportation and Policy Innovation

Public transportation is among the most complex and contentious issues of metropolitan governance. In brief, its “most important role (...) is to provide mobility options for those without the ability to secure transportation at market rates” (Polzin, 2018, p. 45). There are studies dating from the early 20th century discussing the inadequacies of the existing solutions in this policy sector. According to Coker (1920), street railways were a salient issue in the 1910s, when growing U.S. cities debated the regulation and public ownership of urban transportation systems. Some authors (e.g., Castells, 1978; Dunleavy, 1979) suggest that mass transport systems have long been at the center of political disputes of capitalist urbanization because these are commodities predominantly consumed by the working class. Castells (1978, p. 170) argues

that “State intervention in the city (...) politicizes and globalizes urban conflicts by articulating directly the material conditions of daily life and the class content of state policies.”

There are several examples of such conflicts in modern politics. In the postindustrial era, low-income workers are priced out of the urban core and forced to live in areas with fewer public services (Murphy & Wallace, 2010) and, oftentimes, more distance from their workplace. This increases the need for efficient transportation systems, leading to contentious political interests and mobilization strategies across the world. In London, left-wing mayor Ken Livingstone “campaigns on transit modernization”, while right-wing mayor Boris Johnson promised “expanding outer London bus and express rail transit” (Doering et al., 2021, p. 922). In France, Emmanuel Macron’s gasoline tax triggered the Yellow Vest movement to protest in defense of peripheral areas’ low-income residents who were highly dependent on their vehicles to work (*ibid.*).

Considering its contentious characteristics, we posit that public transportation should function as a distributive policy. According to Weingast, Shepsle, and Johnsen (1981, p. 644), a distributive policy is a “political decision that concentrates benefits in a specific geographic constituency and finances expenditures through generalized taxation.” This is likely to occur with mass-transit solutions since they are mostly targeted at lower-income populations who need subsidized alternatives to travel to their workplace and services that are not available at their place of residence. Overall, politicians yield electoral gains from distributive policies since targeted beneficiaries are likely to retribute incumbents with votes (Woodhouse, 2023). This explains this policy sector’s relevance in metropolitan politics.

We add that, besides political considerations, public transportation policies entail a technical dimension. They are responsible for improving mobility in metropolitan regions that face ever-changing technological and spatial landscapes. Some innovative solutions, such as ride-sharing services, may facilitate mobility in big cities but are not enough to eliminate the need for collective modes of transportation. As Polzin (2018) points out, ride-sharing is still not a sustainable alternative for low-income workers without access to a personal vehicle due to its variant and high cost. Furthermore, Watkins (2018, p. 54) contends that “the spatial, environmental, safety, and equity impacts of a transportation system designed around the single-

occupant-vehicle mode are not efficient or sustainable.” Thus, subsidized mass-transit alternatives are still and will remain essential.

In line with this view, recent studies in public transportation seek solutions to increase mass-transit ridership and reduce operational costs (Nnene et al., 2023), collect relevant data on users’ behavior to improve the transportation system (Faroqi et al., 2023), and improve access to disadvantaged populations (Yoo & Lee, 2023), among others. The latter example is especially relevant to our study since it demonstrates the multiple alternatives behind the politics of public transportation reform. When private sector actors, bureaucrats, and elected officials revise bus routes, they consider a series of factors, for instance, the existing demand and population density. Yoo and Lee (2023, p. 4) focus on Sidney (Australia) to propose an additional factor: the “transit service need index.” This social equity tool includes socio-demographic criteria to identify areas and routes most needed by underserved citizens. While their aim is still oriented toward efficient policymaking, the notion of efficiency accounts for the inequalities brought up by the urbanization process.

This literature indicates at least two challenges for policy reform in the public transportation sector. First, the contentious politics of public transportation. The distributive nature of mass-transit solutions will likely favor specific constituencies at the expense of others. Second, its technical aspects. The multiple technological solutions implemented or thought of around the world are not necessarily transferrable to different cities. As said before, while the French working class revolted due to increases in fuel tax, Londoners’ needs were better satisfied by mass-transit solutions. In fact, as Yoo and Lee (2023) show, it is oftentimes hard to separate technical and political aspects, especially when equity considerations could be part of the efficiency calculus.

The policy salience and the multiple technical possibilities lead politicians to engage in policy experimentation. Elected officials may use innovative ideas to improve transportation conditions for specific constituencies in exchange for political support. Some populations, however, may face substantive obstacles in periods of experimentation. Policy changes impose information costs (e.g., learning about new bus routes and payment methods), new habits (e.g., choosing different routes for car drivers), and budgetary constraints (e.g., additional public funds directed to subsidized contracts).

Hong, Kim, and Kwon (2022, p. 2) establish that elected officials will engage in experimentation when there is enough demand for change among citizens (driving both positive change and electoral gains), isomorphic pressures from successful examples elsewhere, and connection between the politician's characteristics and the policy at hand. Policy innovation, therefore, must be desirable from a technical standpoint, as well as visible to potential voters who will reward the incumbent official (Mullin & Hansen, 2023). Following this argument, we develop our theoretical framework proposing that innovative distributive transportation policy will generate electoral rewards for incumbent politicians.

Policy Impact and Electoral Choice

Elections and policymaking are intrinsically connected. Prior research shows that elections serve as a necessary thermometer supporting or opposing reformist agendas (Flom, 2023), they motivate elected officials to direct public and private investments to specific regions (Albertus, 2013; Woodhouse, 2023), and affect politicians' decisions on whether to engage on policy experimentation (Bernecker et al., 2021; Rose-Ackerman, 1980). These studies often posit that office-seeking politicians will design and implement policies that will maximize their chances of winning elections.

There are different ways to understand how voters evaluate policies. Performance-based models posit that voters will reward politicians for successful policymaking. Rewards for successful policymaking range from improvements in citizen satisfaction and institutional evaluation (Charbonneau & Van Ryzin, 2012; Favero & Meier, 2013; Swindell & Kelly, 2000; Van Ryzin et al., 2008) to retrospective voting (Burnett & Kogan, 2017; Fiorina, 1978; Healy & Malhotra, 2013; Hopkins & Pettingill, 2018; Kiewiet, 2000; Woon, 2012). Citizens' satisfaction and retrospective voting are directly related, as the latter represents the citizens' actions on their perception of government performance (Healy & Malhotra, 2013).

While many authors focused on economic policy, the relationship between performance and electoral outcomes is also true for other sectors (Healy & Malhotra, 2013). For instance, Burnett and Kogan (2017) find that voters reward mayors and city councilors in the United States based on the quality of local roads; Berry and Howell (2007) investigate how test scores matter for the re-election of school board members; others study voters' assessment of incumbents' actions following natural disasters (Bechtel & Hainmueller, 2011; Gasper & Reeves, 2011; Healy &

Malhotra, 2009); and how policy decisions made during wars influence popular perceptions and voting decisions (Grose & Oppenheimer, 2007; Karol & Miguel, 2007; Kriner & Shen, 2007). In sum, this literature posits that when incumbents perform well, voters will reward them in the following election.

There are, however, some caveats when relating incumbent performance to electoral rewards. They include (1) biased perceptions, (2) lack of clarity of responsibility, and (3) blurred policy interests. Consider, first, the debate between sociotropic and pocketbook approaches to retrospective voting. Some authors argue that voters consider the overall economic performance, as measured, for instance, through economic indicators are GDP growth, unemployment rates, and inflation (Hansford & Gomez, 2015; Hopkins & Pettingill, 2018; Kramer, 1971). Opposed to that sociotropic approach, scholars propose a pocketbook approach (Fiorina, 1978; Niskanen, 1975), which places personal economic conditions at the center of voters' decision-making process.

There is a natural relationship between sociotropic and pocketbook estimates. Personal conditions are likely to improve when macro-level indicators are performing well. However, individuals hold biased perceptions of reality. They are likely to see the world through more optimistic lenses when they support the incumbent (Healy et al., 2017; Sigelman et al., 1991). Furthermore, in many cases, it is unclear who is responsible for each policy decision, therefore inhibiting the voters' ability to correctly assess the incumbent's performance (Kiewiet, 2000).

Such biases occur when evaluating economic conditions, as well as other types of policy. Instead of performance-based models, some authors, then, propose a cognitive-implicit approach. They posit that voters will positively evaluate the policies implemented by their co-partisans, while rejecting the ones coordinated by undesirable parties and their elected leaders (Andersen & Hjortskov, 2016; Jilke, 2018; Lenz, 2013; Marvel, 2015, 2016). Jilke (2018) finds that this is often the case when the policy responsibility is dispersed and, thus, voters are unable to correctly attribute reward or blame to elected officials. In sum, voters may want to reward incumbents for their performance but may misperceive it due to their partisan bias and inability to understand who designed and implemented the policy of interest.

In addition to that, the obvious targets may not be the ones reacting to certain policy decisions. Holland's (2023) work follows the opposite direction of conventional studies. She finds that the

strongest supporters of new metro stations in Bogotá are not potential users (i.e., the working class). In fact, the policy is mostly supported by upper-class households who do not use public transportation. Her survey study suggests that they want other citizens to use the metro because this will reduce congestion, facilitating their commute.

In sum, the relationship between successful policymaking and incumbent rewards is not as straightforward as some politicians would expect. This is biased by political preferences, blurred by misinformed responsibility attribution, and may be influenced by counterintuitive interests. These issues pose a challenge to policy experimentation. Politicians who decide to engage in policy innovation face the natural risks of experimentation and, if successful, may not be rewarded when running for reelection.

Despite these challenges, we argue that successful policy innovation does lead to *some* electoral rewards. Traditional studies of retrospective voting often consider the whole result of specific electoral districts. This includes different constituencies, for instance, beneficiaries and non-beneficiaries (Holland, 2023), and partisans and non-partisans (Healy et al., 2017). While some studies did capture confirmatory results for the retrospective voting thesis (for instance, Burnett & Kogan, 2017), we posit that positive electoral effects are more clearly identifiable among the direct beneficiaries of successful policy experimentation than if one decides to investigate the whole electoral district.

Voters who have experienced a novel policy that has directly impacted their lives will be more prone to support the incumbent they identify as being responsible for the policy change. We argue that this is likely to take place with innovative public transportation policy, which has the potential to reduce commuting time and costs, especially among working-class individuals. These voters, who are often left behind, will appreciate the politician's willingness to try "something new" and be successful with such experimentation. This personal experience will go beyond partisan preferences, leading beneficiaries to see the incumbent as someone who directly improved their life conditions. Thus, the electoral rewards for the incumbent will be substantially greater in areas where most voters are beneficiaries compared to other areas with fewer (or no) beneficiaries. Empirically, we hypothesize that:

Hypothesis 1: The greater the number of beneficiaries of the public transportation policy in a geographic region, the more voters of this region will favor the incumbent official in the subsequent election.

The Smart Card Policy

Public transportation is a subnational issue in Brazil. Most often, municipalities contract private companies to operate specific bus lines under monopolistic or oligopolistic conditions. These are long-term contracts, which often include fares and fare-change mechanisms, routes, minimum investment, and quality standards. Due to incomplete contracts, technological change, and evolving urbanization, it is common to identify inefficiencies in urban mobility. In 1998, public authorities estimated a diseconomy of R\$ 346 million/year (roughly US\$ 415.2) in São Paulo (São Paulo, 2004).

To address these issues, the newly-elected mayor Marta Suplicy (2001-2004) created an interdisciplinary task force to develop a new mobility plan for the city—the Interconnected São Paulo (in Portuguese, São Paulo Interligado). The task force diagnosed that bus routes were insufficiently interconnected, as many worked on a radial logic, directly linking peripheral neighborhoods to the city center. As urban sprawl was massive by the 80s and 90s (Costa et al., 2021), São Paulo had serious transit problems because bus routes were too long and inefficient. It, then, proposed four main reforms: (i) electronic billing, to promote a faster integration between subsystems and enable the tariff policy; (ii) bus terminal facilities, to improve route integration; (iii) priority for buses on the road system (bus rapid corridors), to create incentives for public transport use, and to improve mass-structural transit; and (iv) monitoring and control, to rationalize the system (São Paulo, 2004). All four areas were the focus of Marta Suplicy's term (see Campos, 2018).

Notice that the contactless smart card (in Portuguese, Bilhete Único) was a central part of a broader plan to improve the municipal public transport system (Campos, 2018). Specifically, it was a technical solution to enable the new tariff policy and the main instrument of trip integration. Instead of waiting long hours to reach the destination on the same bus route, a commuter from the city's outskirts could now improve travel time by combining different routes without paying extra fares. The system facilitated even subsystem commutes by making neighborhood-to-neighborhood connections easier. But the plan could only be accomplished

using the new smart-card technology, as it was vital to allow for automatic fare exemptions when commuters would transfer between buses.

The implementation was divided into four phases. First, in 2002 and 2003, the municipality performed technical tests and finalized all legal arrangements. Second, between January and October of 2003, it provided smart cards to the elderly, who were already exempt from paying fares. This also functioned as the initial experimentation of the policy. Third, between February and May of 2004, the municipality partnered with schools to provide smart cards to its students. In São Paulo, students benefit from a subsidized fare, paying only half price. Simultaneously, it also partnered with many private companies (e.g., Sodexo), which already supplied “transportation vouchers” (i.e., paper tickets) to their employees. Thus, the selected employers began distributing and charging the smart cards for formal workers. In Brazil, these vouchers are paid by the employer in exchange for tax incentives. Fourth, the broader public started receiving their cards after the program’s official launch in May 2004. Users had to register at one of the many offices located all over the city, or at partner institutions, such as the Caixa Econômica Federal (a major public bank).

The government concluded the implementation in February 2005 with millions of users. This policy experiment has completely changed the way citizens pay for public transportation in the city. In fact, the following mayoral administrations partnered with the state government to expand the smart card also to the subway and rail systems (Campos, 2018). The contactless smart card became the main payment means for frequent public transportation users in Brazil’s biggest city. This was, then, replicated in other major municipalities, such as Rio de Janeiro (Neri, 2010).

Empirical Design

Exogeneity Assumption

Our strategy assumes the Smart Card Policy is an exogenous shock, not targeted to any specific group of voters or supporters. Despite affecting commuters all over the city, it did so in different intensities according to pre-existing networks of transport infrastructures that could not be objects of political manipulations (neither through legitimate policymaking nor through any other means in the short term). Such networks are heterogeneously spread across the city of São Paulo. We take advantage of this regional variation to compare the incumbent performance

between different city zones according to the intensity of the Smart Card economic benefits. In other words, we test whether the incumbent performed better in zones where the policy benefits were higher.

Transport networks in São Paulo consist of bus lines, corridors and terminals, train and train stations, and subway and subway stations. Consider the pre-treatment transport networks as given. In some city zones, bus lines are scarce, and commuters must rely on many bus transfers to reach their destinations—to illustrate, let us call it “Zone A.” In others (“Zone B”), commuters are better connected. Because the fare exemptions introduced by the Smart Card treatment are only available to commuters who take one or more bus transfers, policy treatment intensity is a function of the pre-existing transport networks. Thus, to exemplify, the Smart Card treatment intensity is far greater in Zone A than in Zone B. The Smart Card treatment, then, derives mainly from the availability of bus lines (or related infrastructure).

We argue the smart-card policy addressed technical issues of the municipality’s new mobility plan. The incumbent mayor could not intentionally use the smart card to target specific city areas that could render more votes, as the economic effects of the policy were subject to the pre-existing bus network infrastructure. Therefore, we designed our empirical strategy in the following way: for each city zone, we take the difference in the incumbent’s vote share between her initial and subsequent elections as our dependent variable. That is, we measured the policy impact on the growth of the incumbent’s vote share between taking office (baseline) and running again four years later. Our approach is like a difference-in-differences technique, except we only take the first difference since we do not define treated and control units; instead, we only have treatment intensities.

Accordingly, we can only claim causality to the extent that the policy affects some zones more than others in the period after the policy implementation while assuming previous parallel trends between zones. However, due to a lack of data availability, we could not test similar trends from elections before 2000 (our baseline election). To at least partially account for parallel trends, we include the incumbent’s vote share in the baseline election as another explanatory variable since we want to control for pre-existing voting tendencies of each zone.

The exogeneity of the smart card depends on it being uncorrelated to other policy decisions from the mayor or regional voting trends. However, the Smart Card policy could correlate to

confounding factors that also explain the incumbents' performance. For instance, the Bus Rapid System (BRT) was implemented during the same mandate as the Smart Card and could potentially render votes. Additionally, in terms of voting trends, it is well documented that the incumbent labor party experienced a substantial expansion in São Paulo's peripheries during the 1990s and early 2000s (Limongi & Mesquita, 2008). Therefore, our models should control confounding factors and interactions between the Smart Card and other relevant municipal policy variables. Our strategy is straightforward: we run a series of OLS regressions in which we add controls and interaction terms to check to what extent the marginal effect of the smart card remains stable. The stability of the regression coefficient of interest across different models would support the exogeneity assumption.

Data

To regionally evaluate voting behavior and transport patterns, we merge two databases. The first is the electoral database compiled by the Centro de Política e Economia do Setor Público (FGV CEPESP) based on information from Brazil's Federal Electoral Court (in Portuguese, Tribunal Superior Eleitoral or TSE). The second is the Origin and Destiny Survey (OD) from 1997—a study conducted by São Paulo's subway company every 10 years. In addition to the primary data frames, we also collected complementary information to build our control variables. We gathered regional data from the Demographic Census from 2000, and municipal-level information from specific policies implemented between 2001 and May 2004. In this section, we describe in detail the data compilation.

To calculate the *treatment variable*, we rely on the OD Survey. This initiative has interviewed São Paulo metropolitan area residents since 1967. In each interviewee's household, researchers ask questions about the previous weekday trips and social-economic questions. Each observation represents characteristics of a trip taken by someone, such as length and distance, modals used, and zone of origin and destination. Because the database reports information on the zone in which a person lives, it is possible to aggregate individuals' data at a regional level. We defined zone boundaries according to demographics and technical transport criteria. We refer to them as "OD Zones."

We, then, built the treatment variable as follows. As the available data (OD Research) does not identify Smart Card users, we consider the number of bus transfers taken in a trip as a proxy to

Smart Card use at the baseline. A trip with one or more bus transfers is a trip from a potential card user. Treatment intensity will be greater or lower depending on how many people will benefit from the policy. Thus, our treatment variable is the number of Smart Card potential beneficiaries (bus riders that take one or more transfers) with voting age (16 and above) over the total amount of people with voting age in that zone. This equates to the proportion of potential users when the policy was introduced within a specific OD Zone.

Formally, the treatment variable is coded as follows (see Equation 2), where x is the OD Zone of residence of individual i (a resident who is 16 years old or above, and therefore eligible to vote). For this extensive margin variable, the greater the number of residents who are smart card beneficiaries, the greater the value of the variable.

$$SmartCard_x^{1997} = \sum_{i=x}^i \frac{PotentialUsers_i}{AllVoters_i} \quad (2)$$

Our *dependent variable* captures the variation in the number of votes for Marta Suplicy (the incumbent mayor) from 2000 (when she was elected for the first time) to 2004 (when she ran for reelection) in each OD Zone. Although TSE does provide regional data at the municipal level, the electoral zones are very different and more extensive than OD Zones. What we needed instead was more granular vote information, such as polling place data. However, TSE does not gather information aggregated by polling place, only by electoral zone or the ballot box. Thus, we use an aggregation of the TSE ballot box information by polling place (with geo-references) made by the Centro de Estudos da Metrópole (USP CEM). With polling place votes at hand, we simply sum them up at the OD Zone level. We, then, calculate the difference between the votes obtained in 2000 and 2004.

We use a series of *control variables* from two different sources: the Brazilian 2000 Demographic Census and public policy municipal data from the GeoSampa platform. We merged Census and OD Surveys similarly to the electoral variables, except that census data is aggregated in census blocks, i.e., not dots but polygons in a shapefile. In this case, we also had to make the boundaries of census blocks and OD Zones compatible with one another. The next step, then, was to aggregate census information within each OD zone.

Other than demographics, our control variables include proximity to transport amenities and to one of PT's most prominent policies from that period, the Unified Educational Centers (in Portuguese, Centro Educacional Unificado or CEU). The city hall platform GeoSampa has plenty of information about public facilities, such as hospitals, schools, and transport infrastructure. The education database has the geographic coordinates of all CEU locations, making it easy to merge with the OD and the elections data. The CEU policy is a classic example of pork-barrel politics in the sense that PT's administration could target these education facilities to whatever public they wanted. CEUs are large facilities that work simultaneously as public schools and cultural and sports centers open for the people, including theaters, swimming pools, and indoor soccer courts. Because PT advertised the CEU policy intensively, we include it in our regressions as a dummy variable that indicates whether a zone's centroid is closer than 1.0 kilometers from a CEU facility. This is the typical walking distance for education and cultural amenities in Brazil (Neves, 2015). We also tested dummies that use different distance criteria, and the results do not substantially change until a radius distance of 1.5 km.

From the GeoSampa platform, we also extracted available data on the transport infrastructure that was either part of the mayor's new mobility plan or from the governor's rail network (train and subway). From the new mobility plan, we could only include the distance to bus corridors of the BRT system—a salient policy of PT's administration. While the rail system is not a policy under the mayor's jurisdiction (this is a state-level policy), misattribution of responsibilities by voters could be a potential source of confusion. We, thus, account for it. We take train and subway rails as part of the same network, and build a variable that is the distance from the OD Zones centroids to the nearest rail. We do the same with bus corridors and create a separate variable that measures the distance from the zone's centroids. All distances are in meters.

Because the Smart Card policy followed a phase-by-phase implementation, in which some groups of beneficiaries received the card earlier, we explore heterogeneous effects from our sample. Three groups are key here: the elderly, the students, and formal workers that receive the Transport Voucher from their employers. From these three groups, only students (and by the extent their families) could indeed benefit from the transfer fare exemptions. The elderly have always been exempted from paying any fare, while employers pay the fare for their formal workers. We use information from the OD survey and the Census data to build our variables, representing the proportion of each group in the zones' population.

Model

Formally, the empirical model is denoted in Equation 1, where the subscript x accounts for the OD Zones. The coefficient β_1 represents the Smart Card's treatment effect; β_2 is a vector of coefficients for the census covariates X ; β_3 is a vector of coefficients for public policies W implemented between 2001 and May 2004 (before the Smart Card Policy); and ε is the error term. A variation of this model includes an interaction between the treatment variable and W .

$$\Delta VotesMarta_x^{2004-2000} = \alpha + \beta_1 SmartCard_x^{1997} + \beta_2 X_x^{2000} + \beta_3 W_x^{2004} + \varepsilon_x \quad (2)$$

Notwithstanding our efforts to account for all possible confounding factors, there could still be sources of endogeneity in our setting. Of particular concern is the labor party's tendency to over-perform in impoverished areas of the city and under-perform in affluent neighborhoods. As the city's outskirts are the zones with more intense bus transfers, there are good reasons to believe that the Smart Card impact could mix with regional support for PT. In other words, there is a risk of confounding the Smart Card effect to a "periphery effect." Therefore, living in the outskirts could be a source of endogeneity even though we control for socioeconomic variables and within-zone vote trends. To deal with this issue, we propose a matching approach in which we sub-select our sample to compare similar zones in terms of voting behavior and socioeconomic status.

Ideally, we want to compare intensely treated zones in the periphery to their counterparts far from the city center but weakly treated. To systematically choose these zones, we define a dummy treatment variable. Zones above the median of the Smart Card variable were assigned the value 1 (for treated), while zones below-median received the value 0 (non-treated). We match all treated zones to their nearest neighbor among the non-treated zones using a propensity score model.

Findings

Baseline Results

In Table 1, we present the four models that summarize our principal empirical strategy. From models (1) to (4), we successively add new control variables and interaction terms to test the

stability and significance of the marginal effect of the Smart Card variable. After controlling for the baseline voting share of the Labor Party (incumbent), model (1) has a positive and statistically significant effect of the Smart Card policy on the variation of the incumbent's voting share between the 2000 and 2004 elections. More formally, the impact amounts to a 0.37 percentage points (p.p.) increase in the mayor's voting share if we were to increase the Smart Card variable by one p.p. This lends support to our first hypothesis, which posits that the greater the number of beneficiaries of the policy in an electoral zone, the more voters in this zone will favor the incumbent official in the subsequent election.

Table 1. OLS estimates of incumbent party voting difference (2004 - 2000)

	(1)	(2)	(3)	(4)	(5)
Proportion of Smart Card Users	0.370 [0.065]	0.233 [0.063]	0.213 [0.061]	2.635 [1.034]	2.108 [1.264]
Vote share Labor Party (2000)	0.566 [0.056]	0.179 [0.073]	0.141 [0.076]	0.152 [0.071]	0.155 [0.071]
Average Nominal Income (log)		-0.040 [0.006]	-0.040 [0.007]	-0.030 [0.007]	-0.033 [0.008]
Distance to the nearest rail station (Km)		0.004 [0.002]	0.003 [0.002]	0.003 [0.002]	0.002 [0.002]
Distance to nearest bus corridor (Km)			-0.0002 [0.001]	-0.001 [0.001]	-0.001 [0.001]
The proportion of Transport Voucher users		0.043 [0.030]	0.054 [0.029]	0.042 [0.028]	0.022 [0.029]
Proportion of Students			0.037 [0.026]	0.019 [0.029]	0.022 [0.029]
Presence of CEU unit (1 km radius, dummy)			0.058 [0.015]	0.047 [0.015]	0.048 [0.015]
<i>Interaction terms:</i>					
Smart card x Income				-0.376 [0.146]	-0.317 [0.166]
Smart card x bus corridor				0.015 [0.010]	0.015 [0.010]
Smart card x students				0.223 [0.580]	0.176 [0.573]
Smart card x CEU				0.051 [0.183]	0.044 [0.190]
Smart card x rail station					0.018 [0.038]
Smart card x Transport Voucher					0.495 [0.656]
Constant	-0.234 [0.018]	0.174 [0.064]	0.179 [0.066]	0.119 [0.066]	0.119 [0.066]
Interaction terms F-test statistic				12.59	9.15
Degrees of freedom F-test				(df = 5; 601)	(df = 7; 599)
Observations	614	614	614	614	614
Adjusted R-squared	0.278	0.347	0.367	0.406	0.406
Full model F-test statistic				35.97	30.87
Degrees of freedom F-test				(df = 12; 601)	(df = 14; 599)

Sensitivity analysis

If the distribution of smart cards occurred randomly, we could interpret this magnitude as a causal impact, and adding covariates would not change the coefficient of interest. We know that, by design, this was not the case. Still, if our previously discussed exogeneity assumption holds, the coefficient for the treatment variable should be somewhat stable across different model specifications.

We first include three control variables that were not directly subject to the mayor's policies but could correlate with the Smart Card or regional voting behavior. Although already controlling for regional voting tendencies, our primary concern is to rule out the "periphery effect." Thus, in the model (2), we control for the zone's average nominal income. In addition to this, we follow our strategy of controlling for different groups of bus users without the same fare discount benefits. We start by including the proportion of Transport Vouchers users (i.e., the formal workers), which were not the focus of the Smart Card policy in terms of financial support. We do not expect this group to reward the incumbent retrospectively, simply because all their bus transfer savings would go to their employers. Even so, being formally employed could be another source of confusion that is worth controlling. The third confounding variable is the zone's centroid distance to the nearest rail station. As expected, the inclusion of these three variables in the model (2) reduces the magnitude of the smart-card coefficient. However, the effect remains positive, relatively stable, and statistically significant at the 1% level.

Next, we include three more variables in the model (3). This time, more than worrying about theoretical confounders, we know that they were policy choices made by the incumbent mayor. We include the zone centroid's distance to the nearest bus corridor to measure the deliberate policy of improving and expanding the Bus Rapid System in São Paulo. We also include the proportion of students within a zone. Students were one of the first groups to receive the Smart Card, and they received it at schools or universities, meaning that they did not have to seek delivery spots or face long waiting lines to get the card.

Notwithstanding, unlike the formal workers who relied on the Transport Voucher, students and their families benefited from the transfer savings policy. Thus, we do expect a positive retrospective voting behavior from this group towards the incumbent mayor. We controlled for students not only because of the priority given to this group but also because they pay only half of the tariff costs, which means that transfer savings would be less pronounced in absolute terms.

Finally, model (3) also controls for the presence of the CEU facilities. As a typical pork-barrel policy, the mayor would potentially target the CEU facilities in strategic neighborhoods that could render more votes. Because the access to CEUs could correlate to previous bus networks, we must avoid confusion with this policy. Following our exogeneity assumption, after controlling for these three municipal policies, the treatment's coefficient only marginally varies while remaining significant at the 1% level. The impact varies from 0.233 percentage points in the model (2) to 0.213 percentage points in the model (3), a 0.02 difference.

In models (4) and (5), we keep all control variables from the previous models and add interaction terms between them and our treatment variable. Our goal is to test to what extent heterogeneous effects could lead to substantially different conclusions. Because the policy reached groups of bus users at different times, we expect varying marginal effects. We also expect significant policies from the incumbent's mandate (bus corridors and CEUs) to have a marginal impact on Smart Card users.

In model (4), we include interaction terms for those variables likely to have heterogeneous effects. We expect that voters with higher income tend to oppose the labor party due to historical trends from the analysis period; thus, we include the average zone income in the model (4) as one of our interaction terms. Among the groups of users that had fare discounts, students were the first ones to receive the smart cards. For this reason, we also include a student's interaction term in model (4).

As for CEU facilities and bus corridors, these are municipal policies the incumbent could target; as such, we included them in the model (4) because of their potential effects on its beneficiaries. We leave the interaction terms of the proportion of Transport Voucher users and Distance to Rail Stations to model (5) because these variables represent groups of voters that are neither beneficiaries of the smart-card discounts nor direct targets of municipal policies.

The constitutive coefficients from the smart-card policy in models (4) and (5) are not directly comparable to those of the previous models because of the interaction terms. While in models (1), (2), and (3) the treatment variable's coefficients represent the average effects of the policy, in models (4) and (5) we must not interpret the constitutive terms as unconditional marginal effects precisely because the interaction term for each covariate invokes a conditional interpretation.

To recover comparability, we compute the average marginal effect of the Smart Card policy for models (4) and (5) using the average values of each covariate in the interaction terms. By imputing the average values for each covariate and by using estimated coefficients, we compute a marginal effect of the Smart Card policy of 0.1 percentage points on the incumbent's voting share between 2000 and 2004 for model (4). Similarly, we compute an impact of 0.09 percentage points on the vote share in the model (5).

We add that the heterogeneous effects are minor across the different values of our remaining covariates, even though impacts are positive and statistically significant. For instance, the treatment's marginal effect increases the further away commuters are from the rail and rapid-bus systems. Commuters who mostly benefit from bus transfers are usually distant from rail stations and bus corridors. Hence, we theoretically predict that voters who live in zones that lack public transport development depend more on bus transfers.

We perform a conjoint F-test on the null hypothesis that all interaction term coefficients are equal to zero for both models. We reject the null hypothesis at the 1% significance level for models (4) and (5). Although the smart-card policy marginal impact is shorter when compared to the unconditional average effect of models (2) and (3), we still find it substantive and statistically significant. More importantly, the effect size is stable from model (4) to model (5), even after including more interaction terms.

To illustrate the Smart Card's impact on the incumbent's performance, consider the following descriptive data. From the 2000 municipal elections to the 2004 elections, the incumbent mayor Marta Suplicy lost on average -2.2 percentage points across all city zones. Taking the conditional average marginal effects of the Smart Card policy from models (4) and (5) as our preferred parameters, we have an increase of approximately 0.1 percentage points in the incumbent's voting share for a one percentage point increase in the share of Smart Card beneficiaries.

About 25% of our sample zones have no policy beneficiaries, but 5% of voters are beneficiaries in the mean zone. The most intensively treated zone has 30% of beneficiaries. Considering that a five percentage points increase in the smart card variable is reasonable in our sample, the impact on votes would reach up to 0.5 points, which amounts to more than 20% of the vote share average fall. Such marginal differences could be decisive in competitive elections. In 2004, Marta obtained 35.82% of the votes in the first round elections, while José Serra, her main

competitor, obtained 43.56% (7.74 p.p distance). In the second round, she lost by a difference of 9.72 p.p. In 2000 she reached 34.40% of the votes in the first round (17 points more than the second place) and won the second-round elections with 58.51% of the votes (while Paulo Maluf reached 41.49%).

The Matching Approach

One competing explanation for our results, as we previously explained, regards the “periphery effects” of São Paulo. Voters of higher-income neighborhoods typically vote against the left-wing PT, which is most supported in the city’s low-income regions (Limongi & Mesquita, 2008). Because our exogeneity assumption depends on territorial patterns, it is difficult to partial out the effects of historical partisan trends on the real influence of the smart-card policy. To circumvent this problem, we adopt a matching method that selects only comparable zones. We systematically exclude most zones from the affluent central district and end up with a sample of middle-to-long distant regions. Some of the remaining zones are better provisioned by train, subway, and bus corridors, but others are not. Most likely, the under-provisioned zones are where bus transfers are widespread, and policy impacts are higher. The matched sub-sample allows us to compare these two zones where the income influence is less pronounced.

In Figure 1, we show that our initial sample is unbalanced for most variables of our propensity score model. Treated zones, which we defined as having above-median values of the Smart Card variable, are substantially different than non-treated zones (below the Smart Card median). However, the graphical analysis shows that after adopting the nearest neighbor matching, we successfully reduced the discrepancy between zones, making them more comparable. The sub-sample of matched zones has six out of eight variables below the threshold of 0.1 absolute standardized mean differences (our primary metric for balance). Although we would ideally want all variables to be balanced, the two unbalanced variables are close to the threshold and substantively improved after the matching. More importantly, average income and related social-economic variables were successfully balanced. Therefore, we are confident that the new sample corroborates our strategy of ruling out the “periphery effect.”

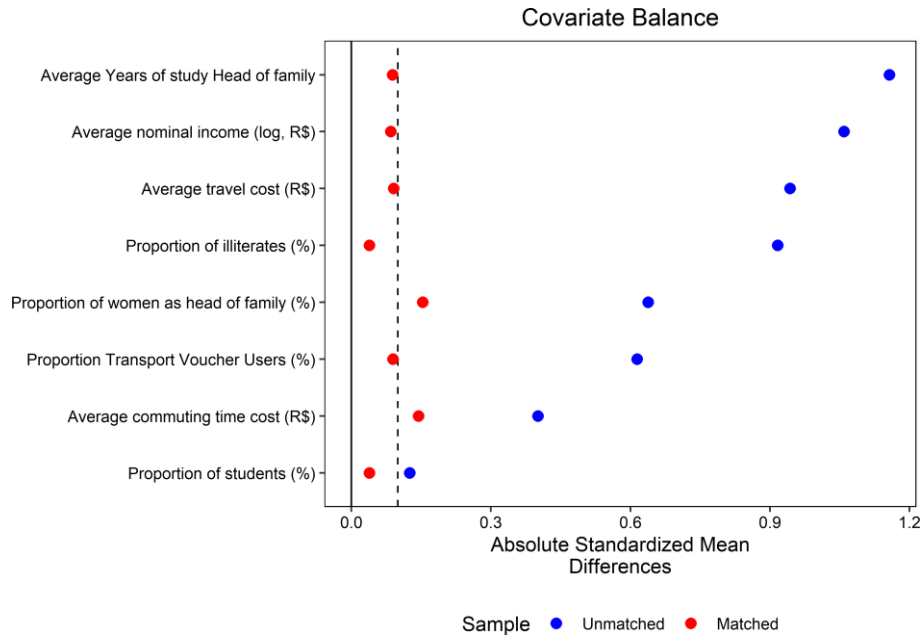


Figure 1. Matching Covariate Balance

Table 2 shows the same set of regressions from Table 1, but using the matched sample. Notice that estimates for models (1)-(3) are similar in both samples. Not only estimates for the treatment variable are stable, but also for most of the covariates. Additionally, most coefficients remain correctly signed and statistically significant. Models (4) and (5) are more difficult to compare due to sample variance, but the results are also similar. In model (4), we find that conditional on covariate means, the impact of the smart card on votes reaches 0.16 percentage points. In model (5), the same parameter is 0.15 percentage points. The full sample models have similar impact values of 0.10 and 0.09, respectively. Accordingly, statistical significance is also present in the matched sample.

Table 2. OLS estimates of incumbent party voting difference (2004-2000) using a matched sample

	(1)	(2)	(3)	(4)	(5)
Proportion of Smart Card Users	0.316 [0.088]	0.230 [0.079]	0.194 [0.078]	0.395 [1.306]	-0.659 [1.713]
Vote share Labor Party (2000)	0.795 [0.093]	0.209 [0.106]	0.14 [0.109]	0.153 [0.109]	0.169 [0.108]
Average Nominal Income (log)		-0.075 [0.012]	-0.074 [0.012]	-0.071 [0.017]	-0.078 [0.019]
Distance to the nearest rail station (Km)		0.004 [0.003]	0.004 [0.003]	0.003 [0.003]	0.0001 [0.006]
Distance to nearest bus corridor (Km)			0.0001 [0.001]	-0.001 [0.001]	-0.001 [0.002]
The proportion of Transport Voucher users		0.023 [0.041]	0.033 [0.042]	0.029 [0.042]	-0.023 [0.065]
Proportion of Students			0.080 [0.041]	0.080 [0.062]	0.090 [0.063]
Presence of CEU unit (1 km radius, dummy)			0.053 [0.019]	0.025 [0.032]	0.028 [0.032]

Interaction terms:					
Smart card x Income				-0.045 [0.179]	0.073 [0.217]
Smart card x bus corridor				0.010 [0.013]	0.013 [0.014]
Smart card x students				0.024 [0.775]	-0.086 [0.762]
Smart card x CEU				0.237 [0.253]	0.215 [0.264]
Smart card x rail station					0.040 [0.057]
Smart card x Transport Voucher					0.833 [0.871]
Constant	-0.311 [0.03]	0.410 [0.109]	0.400 [0.108]	0.383 [0.135]	0.444 [0.155]
Interaction terms F-test statistic				2.65	2.12
degrees of freedom F-test				(df = 5; 409)	(df = 7; 407)
Observations	422	422	422	422	422
Adjusted R-squared	0.251	0.386	0.402	0.401	0.401
Full model F-test statistic				24.46	21.12
degrees of freedom F-test				(df = 12; 409)	(df = 14; 407)

When we look at the heterogeneous effects in the new sample, results repeat the same patterns, except for the behavior of the income variable. We no longer verify the decreasing marginal effects of the smart-card variable for higher values of income. We believe this is because we successfully ruled out the “periphery effect” in our matched sample. Figure 9 makes our point by showing the marginal effect conditional on income for model (5). Since results are overall robust across samples, we are confident that our exogeneity assumption sufficiently holds. In other words, our main results and our robustness check confirm the hypothesis that, to a relevant extent, voters rewarded the incumbent mayor based on the gains provided by Smart Card.

Discussion and Conclusion

In this paper, we demonstrate that the beneficiaries of successful policy innovation become more likely to vote for the incumbent. This occurs despite pre-existing voting patterns, the presence of other pork-barreling policies, and the use of technical factors to decide where and how the innovation will be implemented.

This finding contributes to a long-standing tradition of studies investigating retrospective voting (e.g., Berry & Howell, 2007; Fiorina, 1978; Healy & Malhotra, 2013; Hopkins & Pettingill, 2018; Woon, 2012). However, our design provides robust confirmatory evidence based on a series of novel approaches, namely, the focus on public transportation policy rather than

economic issues, the investigation of sub-municipal effects, and an effect that goes beyond the traditional cases of pork-barrel policymaking.

Public transportation is a contentious topic explored by politicians in different arenas (Doering et al., 2021). It involves political, economic, and technical aspects (Yoo & Lee, 2023) that impose barriers to focusing on the incumbent's specific electoral basis. Still, this is also a distributive policy because it "concentrates benefits in a specific geographic constituency and finances expenditures through generalized taxation" (Weingast et al., 1981, p. 644). Overall, it is focused on solving pressing economic issues that are prevalent in the changing landscape of major cities, including increasing commuting time, high life costs, and pervasive economic inequalities.

The Bilhete Único reduced time and costs spent in São Paulo's mass-transit system because its automated fare collection system allowed integrated ticketing. Users could ride different busses for 120 minutes to reach their destination paying a single fare. The policy initiated by Marta Suplicy's government in 2001 and fully implemented in 2005 resulted in over 8.5 million smart-card users accessing roughly 15,000 busses in the municipality.

While the policy resulted in a major transformation in the city, we have no reason to expect that non-beneficiaries would reward the incumbent mayor. Holland (2023) investigated Bogotá's metro expansion to find that non-users (the upper classes) approved the policy since it would reduce traffic and, therefore, improve their lives. We posit that while the wealthy could benefit from the Bilhete Único, it was the working class of specific geographic regions (the smart card users) who received its main benefits. This explains why they adjusted their voting patterns in favor of Marta Suplicy.

Our research design considers the georeferencing of transportation and electoral data to split the municipality of São Paulo into multiple OD Zones. We compile a panel of sub-municipal data that also includes other local-level policies, the different types of early adopters (i.e., students, the elderly, and formal workers), and socio-demographic information. This allows a series of sensitivity tests and provides robust evidence that this policy innovation caused retrospective voting the more beneficiaries each OD Zone had.

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