The Effect of Fare-Free Public Transport on Mode Choice:
Evidence from São Caetano do Sul, Brazil

Extended Abstract

Aidan Rossi de Araujo[1] and Prof. Dr. André Luis Squarize Chagas[2]

[1]Master Candidate at Economic Department at the University de São Paulo (USP)
[2]Professor at Economic Department at the University de São Paulo (USP)

1 Motivation and Research Question

Fare-free public transport (FFPT) has spread rapidly across Brazil, reaching roughly 150 municipalities by mid-2026 and covering on the order of 7 million people. Yet the whole-metropolis experience is absent, and the behavioural consequences of the policy in dense metropolitan settings remain empirically open. Does eliminating the fare actually change how people travel, or does it mostly transfer income to those who already ride the bus? And if travel behaviour changes, *who* changes it?

This paper studies the case of São Caetano do Sul (SCS), a dense, high-income municipality of about 165,000 inhabitants in the São Paulo Metropolitan Region (SPMR), within the industrial ABC belt. SCS is among the ten most populous Brazilian cities to have adopted FFPT. It is richer, older and whiter than the SPMR average, with a pronounced "car culture" rooted in its automobile-industry history (about 0.75 cars per adult, against 0.61 regionally). Crucially, many people who work in SCS commute in from poorer neighbouring cities: average household income is about R$6,465 for in-commuters against R$9,843 for residents. This resident/non-resident income gap is central to the distributional reading of the policy.

The paper asks whether the introduction of free municipal public transport in SCS changed the modal composition of mandatory trips (to work and study), which population groups drove that change, and how the welfare gain — measured through consumer surplus — compares with the fiscal cost of the policy.

2 Data and Identification

The empirical strategy exploits a fortunate coincidence of timing. The policy took effect on 1 November 2023, in the middle of the fieldwork window of the 2023 Origin–Destination (OD) Household Survey for the SPMR, produced by the São Paulo Metro. The OD is a public, household-based survey; the 2023 edition collected roughly 143,000 trip records from about 79,000 people. Because part of the sample was interviewed before the policy and part after, trips observed *without* free fares can be used to identify structural preference parameters, which are then used to impute the counterfactual choices of travellers exposed to the policy.

The discrete choice model is estimated on 72,413 work/study trips using one of four modes — public transport, car, motorcycle, walking — across the whole SPMR. The treated group comprises 346 trips with origin or destination in SCS after 1 November 2023. Since the OD records neither trip cost nor precise network time, these were estimated: routes and times from the Google Maps APIs (calibrated to observed durations via an XGBoost error-correction model), fares from a fare-integration algorithm reflecting the Bilhete Único and TOP cards, fuel prices from the National

Petroleum Agency, and vehicle efficiency from the Inmetro labelling programme. Public transport is treated as a single integrated mode rather than disaggregating municipal bus, intercity bus, train and metro.

The identifying assumption is that structural preferences do not change before and after 1 November 2023, so control and treated travellers choose on the same basis and the only element distinguishing them is the free municipal fare. This approach, inspired by Athey et al. (2021), differs from the more common *ex ante* simulation: rather than assuming a demand system and simulating a hypothetical shock, it recovers the counterfactual from trips actually observed without the policy.

3 Method

Mode choice is modelled with a Multinomial Logit (MNL). The utility that mode m delivers to the traveller on trip i is

$$U_i^m \;=\; \alpha^m + Z_i^\top \boldsymbol{\alpha}^m + \beta_{tt}\, tt_i^m + \big(\beta_p + \gamma_p\, Ie_i\big)\, p_i^m + \varepsilon_i^m, \tag{1}$$

where α^m is a mode-specific constant, Z_i a vector of socio-demographic and trip covariates, β_{tt} and β_p generic sensitivities to travel time tt_i^m and monetary cost p_i^m, and γ_p captures heterogeneity in cost sensitivity with respect to mean-centred log per-capita household income Ie_i. The error ε_i^m is i.i.d. Gumbel and walking is the reference mode. The model is estimated by maximum likelihood on the control group (untreated trips) using the `Apollo` package (Hess & Palma, 2019).

The object of interest is the average treatment effect on the treated (ATT) for each mode: the difference between the treated group's observed choices and what it would have chosen absent free fares. The counterfactual is imputed by restoring the R$5.00 fare for each treated trip and recomputing MNL probabilities. Statistical significance is assessed with a Krinsky–Robb parametric bootstrap (1,000 draws).

To weigh benefits against fiscal cost, the change in consumer surplus is computed from the log-sum formula (Train, 2009). Because the marginal disutility of money declines with income ($\lambda_i = |\beta_p + \gamma_p Ie_i|$), lower-income travellers register a larger money-metric surplus per unit of utility, which lets the analysis speak directly to the distributional incidence of the policy.

4 Main Results

Mode substitution. The public transport share of mandatory trips rises by about 5.3 percentage points, from 23.1% to 28.3% — a relative increase of roughly 22%. This gain is drawn from a fall in car and, especially, motorcycle trips, alongside an increase in walking (Table 1, Figure 1). Every effect is significant at the 5% level. The fall in motorcycle use is the largest in proportional terms, consistent with the motorcycle being the most income-sensitive mode and associated with lower-income travellers in the SPMR; because reduced motorcycle use is linked to fewer accidents, this shift may carry safety co-benefits beyond the model's scope.

Table 1: Policy effect on modal shares in the treated group

Mode	Observed (%)	Counterf. (%)	Effect (p.p.)	CI low	CI high	p-value
Walking	25.72	21.00	4.70	2.34	6.90	< 0.001
Car	41.33	44.60	−3.28	−6.07	−0.12	0.042
Public transport	28.32	23.10	5.26	2.39	7.45	< 0.001
Motorcycle	4.62	11.30	−6.69	−9.23	−4.12	< 0.001

Notes: Effect = observed share − estimated counterfactual share. Counterfactual obtained by adding R$5.00 to the public transport fare of each treated trip and recomputing MNL probabilities. Krinsky–Robb bootstrap (1,000 draws); normal-approximation 95% CIs.

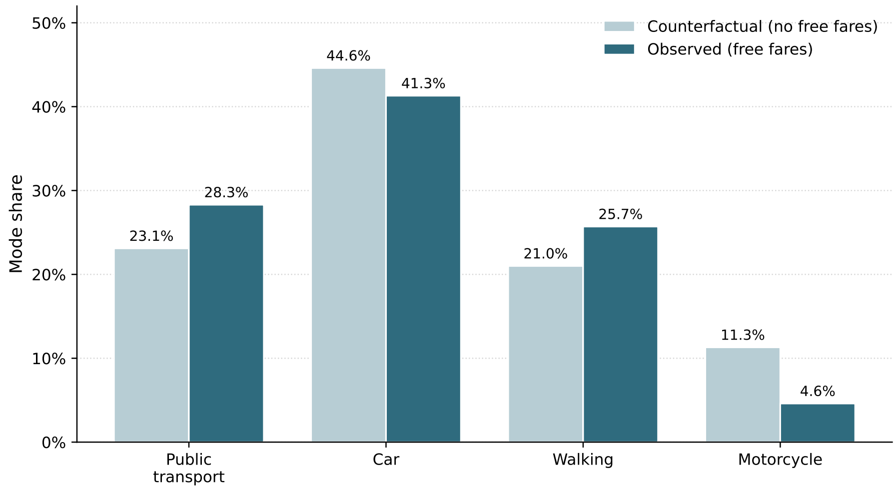

Figure 1: Estimated counterfactual (no free fares) versus observed modal shares under free fares, treated group. The difference between the bars is the estimated policy effect.

Who switches. Although every demographic group increases its use of public transport, the shift concentrates among non-residents of SCS, non-white travellers, individuals below median income, and those under 40. Since SCS is richer and whiter than the SPMR, and in-commuters earn about a third less than residents, this points to an equity-enhancing effect. The pattern also carries a policy tension: the municipality subsequently restricted free fares to residents, a change that would fall hardest on exactly the non-resident workers and students who switched most.

Elasticities. Public transport exhibits the largest own-price elasticity in absolute value among all modes (a 10% fare increase lowers its demand by about 0.157 in proportional terms) as well as the largest own-time elasticity, with car and motorcycle absorbing most diverted trips. Its negative income elasticity indicates it behaves as an inferior good relative to the car, underscoring the role of public coordination in sustaining ridership as incomes rise. The estimated Value of Time is about R$30.82/hour, roughly 53% of the mean hourly wage — close to the standard 50% benchmark.

Welfare and benefit–cost. The average consumer surplus is R$0.64 per trip touching SCS, distributed progressively: the bottom income tercile captures surplus worth about 1.2% of monthly income, against under 0.1% for the top tercile; among direct public transport users the bottom tercile receives about 7% of income against 1.6% for the top. Aggregating over the 327,662 SCS-linked trips represented in the OD gives a total surplus of about R$49.7 million per year, above the R$35 million annual fiscal cost, for a benefit–cost ratio of roughly 1.42 — before counting environmental, accident, or congestion co-benefits. A supplementary, illustrative exercise on observed car speeds (11.7 vs. 12.95 km/h) suggests a decongestion channel that would raise the ratio to about 2.04 if taken at face value, though it is not statistically distinguishable from zero given the small post-policy sample.

5 Robustness

Three checks support the central finding. A *temporal placebo* with a fictitious start date of 1 October 2023 yields no significant effect on the public transport share (+0.12 p.p., $p = 0.912$), ruling out a pre-existing trend. A *spatial placebo* applied to the neighbouring ABC municipalities of Santo André and São Bernardo do Campo — which did not adopt free fares — produces no significant effect for any mode. An alternative *GTFS routing* specification (via the `r5r` package) confirms the direction and significance of the effect, with a larger magnitude attributable to the smaller price variance in that restricted sample. The core result — a rise in the public transport share at the expense of car and motorcycle — is robust to different time windows, spatial samples, and sources of time and cost data.

6 Contribution and Concluding Remarks

The paper makes two contributions. Substantively, it adds applied evidence on the mode-substitution effects of FFPT in a dense metropolitan setting, finding a genuine shift away from private vehicles rather than a pure income transfer, and documenting who benefits. Methodologically, it uses a discrete choice model to impute the counterfactual for an *ex post* policy evaluation, exploiting a survey window that straddles the policy's introduction — a design transferable to other settings where a behavioural survey happens to bracket a policy change.

Several limitations frame future work. The model holds transport supply fixed, so changes in routes, frequency, fleet and crowding are not captured; the 143% jump in municipal bus boardings in the first month points to substitution from intercity to municipal buses and possibly induced demand, neither fully modelled here. The focus on mandatory trips excludes leisure and shopping, which may account for much of the off-peak impact, and a single cross-section cannot capture long-run responses such as vehicle-purchase decisions. Finally, the results highlight the value of coordinating transport agencies above the municipal level, since efficiency gains on municipal buses appear to coincide with under-utilisation of intercity lines.

References

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