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Extended Abstract Submission

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City-wide Cycling Network Extension and Bicycle Ridership in São Paulo: a Causal Analysis

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This work addresses the following topic(s) from the Call for Contributions:
(Please check at least one box)

☐ Placemaking to integrate urban spaces and mobility
☒ Promoting sustainable mobility choices in metropolitan regions
☐ Governing responsible mobility innovations
☐ Shaping the transition towards mobility justice
☐ System analysis, design, and evaluation
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Extended Abstract

Word count = 925 (excluding figure captions and tables).

Problem statement

Promoting urban cycling has emerged as a key strategy in cities worldwide to address contemporary mobility challenges, given its multifaceted benefits and cost-effectiveness. Research across environmental, economic and health domains has consistently highlighted the advantages of cycling. Consequently, urban cycling is progressively gaining prominence in public policy agendas as a promising transportation alternative, given its benefits. This trend extends to megacities in upper-middle income countries like Brazil, where currently there are strong efforts to expand bicycle infrastructures and support cycling. São Paulo serves as a compelling case. Since the 2010s, the city has invested heavily in improving cyclability, including the implementation of dedicated bikeways and the development of the Municipal Bicycle Master Plan (2019-2028)[1].

In spite of the generally positive impacts associated with the establishment of cycling infrastructures, their implementation can be financially burdensome and disputed in cities where a significant portion of the population is car-reliant (Rodriguez-Valencia et al., 2019). Therefore, gaining a deeper understanding of their effectiveness (causal evidence) in promoting cycling becomes paramount for shaping future cycling investments. Moreover, up to this point, only a small number of authors have investigated the causal effects of city-wide cycling networks in

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[1] The Municipal Bicycle Master Plan (2019-2028) aims to define the city's cycling network and its supporting elements. Oriented towards structuring an integrated network, it encourages multimodality and connection with the main public transport facilities, ensuring the safety of cycling on the city's road network and promoting actions to increase.

Latin American cities of similar scale to São Paulo, as exemplified in the work by Rodriguez-Valencia et al. (2019) in Bogotá. This underscores the pressing need for more studies in this category.

Another challenge that needs more research efforts in (quasi-) experimental cycling studies is the proper identification of populations exposed to interventions, given that travel is often 'from somewhere to somewhere' (Aldred, 2019). Frequently, studies rely on simple proximity measures, which use the distance from the intervention to the place of residence to stratify populations by exposure status (see e.g. Goodman, Sahlqvist, & Ogilvie, 2014; Rodriguez-Valencia et al., 2019). However, the impact of distance can be strongly dependent on key travel Origins and Destinations (ODs) of individuals. Even if they reside in close proximity to new bike routes, it may not necessarily be useful for them if they have neither a need or desire to travel to the areas it links.

Research objectives

In light of the presented gaps, this work aims to provide evidence on the causal effects of the implementation of bicycle infrastructure on ridership in São Paulo, specifically for people exposed to such infrastructures. More specifically, our study seeks to model the causal relationship between the implementation of a network of cycling paths and lanes, and the individual probability to cycle for different use cases (work, leisure, shopping and education).

Methodological approach

Using two cross-sections of the Household Origin-Destination Survey (2007:2017) developed by Metrô de São Paulo, a public organization managed by the State of São Paulo[2], we develop difference-in-differences (DiD) estimators combined with binomial logit regressions to analyze whether the probability of using the bicycle in 2017 has changed due to the completion of cycling routes that were implemented between two analyzed cross-sections, and compare how such changes differ among treatment and control groups of similar areas. DiD, which has been used in other quasi-experiments to examine the impact of new bikeway facilities (Dill et al., 2014; Rodriguez-Valencia et al., 2019), is capable of eliminating time-invariant differences between treatment and control groups, thus dropping possible sources of bias when estimating effects.

Two geographic approaches are tested to assess exposure of residents to new bikeways and, consequently, to delineate treatment groups: a) Distance based exposure and b) an Origin-Destination (OD) based exposure. The first approach defines exposure as the percentage of OD zones that overlap with 500-meter buffers generated from the implemented cycling routes (see Figure 01). In the second approach, we assume that individuals would benefit from these routes if a portion of the OD lines align parallel to the geometry of cycling routes and intersect the buffers generated from them. For each of the described exposure calculations, infrastructure effects are estimated and discussed.

[2] Since 1977, the OD survey has been a key instrument for São Paulo's transport planners, as it provides valuable data for understanding metropolitan daily travel patterns.

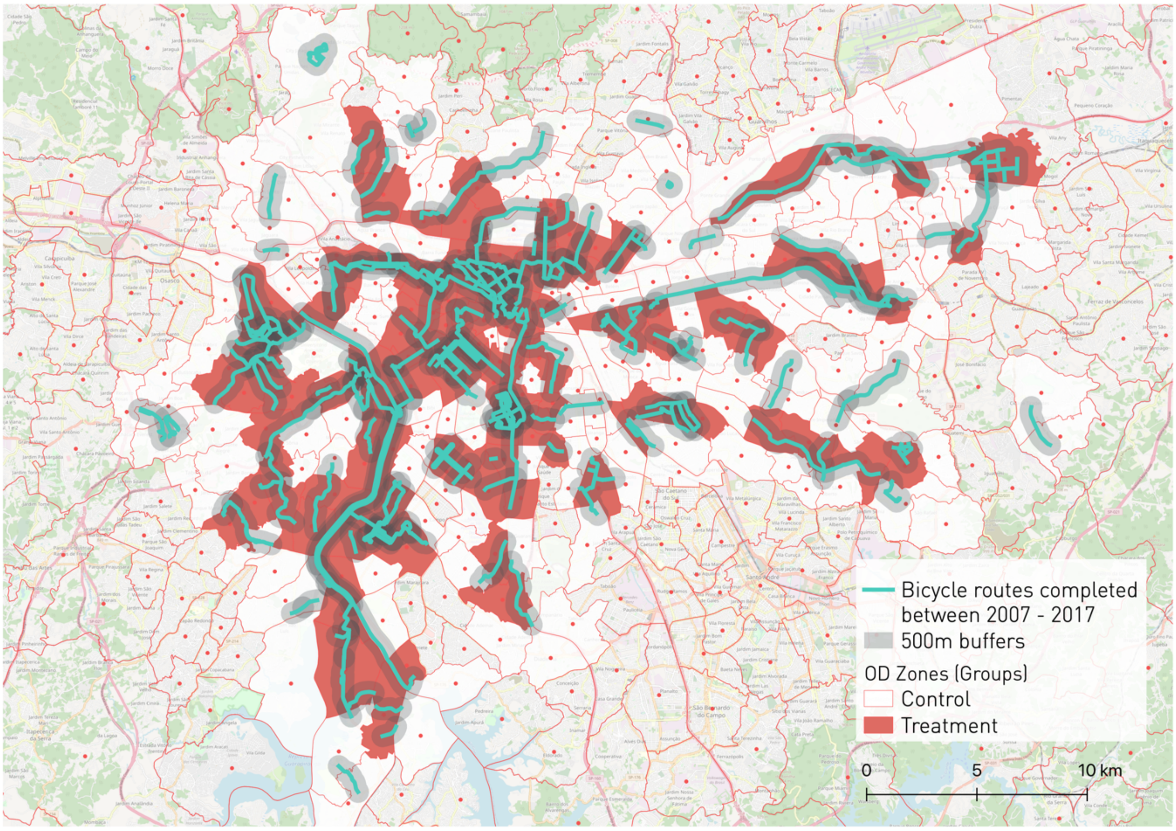

Figure 1: Cycling routes implemented between 2007 and 2017; and OD zones classified as treatment and control groups.

(Expected) results

Our preliminary findings suggest that the introduction of new cycling routes has caused city-wide positive mode choice changes towards cycling. More specifically, after considering relevant controls, our results suggest that more people used bicycles instead of other modes after the implementation of cycling routes with an increase around 1% (see Table 01) in the predicted probability of cycling after the intervention. After using different exposure calculation methods, we expect to find some variability in the causal effect of those infrastructures. The influence of important controls (demographics, travel characteristics) will also be discussed in light of previous studies.

To the best of our knowledge, this study is one of the few quasi-experiments that examine changes in bicycle mode share over time as a result of the construction of large-scale cycling networks in large South American cities such as São Paulo. Policymakers can use our results to support future cycling investments by building the value-case for cycling routes as facilities that can produce net benefits even in cities that are highly car-reliant.

Table 1: Preliminary regression results.

	Model 1			Model 2		
	Coefficient	SE	AME	Coefficient	SE	AME
Treatment Group	-0,43***	(0,07)	-4,09e-03***	-0,42***	(0,07)	-2,64e-03***
Year (2017)	-0,21***	(0,05)	-1,94e-03***	-0,22***	(0,05)	-1,41e-03***
*Treatment*Year (2017)*	0,88***	(0,09)	1,16e-02***	0,89***	(0,09)	8,18e-03***
Demographics						
Gender (Woman)	-	-	-	-1,93***	(0,06)	-1,47e-02***
Age	-	-	-	-0,01***	(0,001)	-5,44e-05***
Trip characteristics						
Trip distance	-0,0001***	(0,00)	-1,19e-06***	-0,0002***	(0,00)	-1,01e-06***
Home	-	-	-	0,86***	(0,08)	5,78e-03***
Leisure	-	-	-	0,88***	(0,14)	8,91e-03***
Work	-	-	-	1,27***	(0,08)	1,21e-02***
Constant	-4,01***	(0,04)	-	-3,94***	(0,08)	-
Observations		192.182			192.182	
Log Likelihood		-11.926,74			-11.066,21	
AIC		23.863,47			22.152,41	

Notes: Standard errors (in parentheses) are clustered on the O-D pair. Significant at *10%, **5%, ***1%.

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