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Public transport and school location impacts on educational inequalities: Insights from São Paulo

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ABSTRACT

In many large Latin American urban areas such as the São Paulo Metropolitan Region (SPMR), growing social and economic inequalities are embedded through high spatial inequality in the provision of state schools and affordable public transport to these schools. This paper sheds light on the transport-education inequality nexus with reference to school accessibility by public transport in the SPMR. To assess school accessibility, we develop an accessibility index which combines information on the spatial distribution of adolescents, the location of existing schools, and the public transport provision serving the school catchment area into a single measure. The index is used to measure school accessibility locally across 633 areas within the SPMR. We use the index to simulate the impact of a policy aiming at increasing the centralisation of public secondary education provision, and find that it negatively affects public transport accessibility for students with the lowest levels of accessibility. These results illustrate how existing inequalities can be amplified by variable accessibility to schools across income groups and geographical space. The research suggests that educational inequality impacts of school agglomeration policies should be considered before centralisation takes place.

1. Introduction

Inequalities in educational and transport infrastructure are mutually reinforcing: the right to mobility is intrinsically linked to the right to education. Travel to school options are vital for ensuring a more equitable supply of educational opportunity to diverse groups. Conversely, poor accessibility to and from deprived areas can reinforce social inequalities, with long-term implications. Against this background, in this paper we propose a new way to measure school accessibility in local areas within an urban area, and apply it for the case of the São Paulo Metropolitan Region (SPMR).

The SPMR presents an excellent opportunity to measure the extent of educational and public transport provision, and to study the impact of public policies on different socio-economic groups. Partly as a response to the pressures from the Free Pass Movement that started in March 2013, low income public school students residing in the SPMR gained access to a public transport subsidy in 2015. However, in October 2015, the São Paulo state government announced during a television interview that as part of a budgetary deficit reduction plan, selected secondary schools would be closed in 2016. The change in policy was estimated to affect more than 300,000 students, many of whom would be placed in schools far from their homes. As a response, in the following months students occupied over 200 schools. Protesters scored some victories: the reform was postponed for one year, and the education secretary resigned (Ortellado, 2015).

Although this time the policy change was not carried out, in a context of high spatial inequalities in the provision of public transport and schooling, it is worth asking whether a public transport subsidy for students can compensate for the lower provision of public schools in some areas. In this dynamic and highly political context, new quantitative evidence can help shed light on the relationship between transport and educational inequalities and the extent to which they are mutually reinforcing. Moreover, the results should help design school location and public transport policies that are more inclusive and equitable by highlighting areas where school location and public transport opportunities conspire to exacerbate educational inequalities.

The recent experience of São Paulo and other cities informed the paper's public transport emphasis. This could be seen as a contrast to the topic of active travel to school, which has gained recent prominence in Australia (e.g. Veitch et al., 2017) the USA (Lee et al., 2017) and Europe (e.g. Macdonald et al., 2016). However, we see great potential synergies between provision of public and active transport

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opportunities and, by focussing on public transport, do not wish to endorse an 'either or' approach to adequate school travel opportunities. The focus on public transport is especially appropriate in a Latin American context where parents' perception of road danger may (rightly) be greater and where parents cannot be expected automatically to be able to have the resources to buy and maintain a bike for children to cycle to school.[1]

Our proposed competitive accessibility measure combines information about the place of residence of students, the spatial distribution of public schools, and public transport accessibility into a single measure. We start from a cumulative opportunity measure that counts the number of schools seats that can be reached within a 30-min journey by public transport, and then build a competitive measure that takes into account the place of residency of teens. Travel-to-school times by public transport are based on actual commuting times obtained through use of routing algorithms provided through an on-line service.

For this work we used the Google Matrix Distance API (Application Programming Interface), a multi-modal real-time travel data provider.[2] The API was used in preference to other options, such as Routino — see Singleton (2014) for a used case involving large-scale accessibility analysis — and the OpenStreetMap Routing Machine (OSRM) because its ease of use (requiring no new software to be installed locally) and performance: the Google Distance Matrix API returns route distance, price (but not price for travel to school) and times for journeys between origins and destinations, provided either as Longitude/Latitude pairs or as text strings to be ' geocoded' (converted to geographical location).

We calculate these measures for 633 areas within the SPMR. We use the competitive measure to simulate the impact of a policy change in the location of public secondary schools, in order to, first, understand the extent of spatial inequalities in school accessibility by public transport, and second, estimate the effect of different scenarios of a policy aiming at concentrating public secondary education provision on school accessibility. We find that closing down schools in areas with lower than average provision is highly regressive: it negatively impacts students with the lowest accessibility levels, accentuating existing inequalities.

The first well-known quantitative definition of accessibility was by Ingram (1971). This seminal paper presented a range of measures determined by distances to destinations (Euclidean and network), natural barriers and distance decay functions. This early work made the distinction between accessibility indices that apply to zones or single 'desire lines': "relative accessibility is defined as a measure of the effort of overcoming spatial separation between two points, while the integral accessibility is defined as a measure of the effort of overcoming spatial separation between a point and all other points within an area" Allen et al. (1993). In subsequent works, the measurement of job accessibility by particular transport modes has received vast attention in the literature (Geurs and Van Wee, 2004), while studies on access to education has largely focused on the consequences of mode choice on socio-economic indicators and school outcomes (see for instance Asahi, 2014, Falch et al., 2013 and Dickerson and McIntosh, 2012 on the impact of accessibility on school outcomes, and Andersson et al., 2012 and Easton and Ferrari, 2015 on the effect of changes in travel-to-school patterns in developed economies).

Our index is inspired by the index developed by Shen (1998) in the context of job accessibility. The main innovative element with respect to previous proposed measures of school accessibility is that it takes into account both the 'supply' and 'demand' for schooling in each area. Concretely, it is based on the idea that in each local area, there is a certain amount of students in (secondary) school age, and a certain quantity of (public) school seats available. As areas are part of a city, each local area is also subject to the inflow of potential students from other areas, as well as of the outflow of students to other areas. The magnitude of the net flow will depend on the travel distance between all other areas and the area in question, which here we consider to be the public transport commuting time between areas. The index thus captures the fact that students compete for school seats, which are limited in number, and distributed unequally across space. The inclusion of this competitive element to school accessibility, akin to that in job access, highlights the fact that under certain educational systems, the access to opportunities is mediated by competition.

Our work contributes to the literature on transport-related social exclusion (Jones and Lucas, 2012; Lucas et al., 2016) by providing a quantitative way to assess multiple dimensions into a single measure. Education and public transport are both essential public services, and thus are part of the set of fundamental and universal human rights. Lack of sufficient access to these services limits the way in which individuals can use their capacities and exercise their rights in a context of equal opportunities (Gomide, 2003). Our index provides a benchmark to compare access inequalities in countries with unequal provision of public services (Gomide, 2006; Pacione, 1989). Considering contestation as the process through which social groups mobilize in an organized way in order to impede the implementation of unwanted policies, or force the negotiation of new conditions, our index allows embedded inequalities to be better understood.

After this introduction, we detail our data sources and definitions in Section 2 . Section 3 describes the area of study and presents some preliminary findings. Section 4 describes the proposed methods for measuring school accessibility. Section 5 presents the results for the SPMR, and finally, Section 6 concludes.

2. Data

The school accessibility index was created using data from the following sources:

- Demographic Census – 2010 – IBGE
- Origen – Destination Survey – 2007 – Mêtro
- School Census – 2008 – INEP
- Geocoded Schools – CEM/CEBRAP – 2001
- Geocoded Public Schools – SEADE – 2008
- Google Distance Matrix API

The School Census data was provided by the Brazilian National Institute of Educational Studies and Surveys (INEP). The dataset contains information on all public educational institutions, including a unique identifier and the number of students enrolled in secondary education. School coordinates contained in a database provided by the Center for Metropolitan Studies CEM (*Centro de Estudos da Metrópole*) for 2001 were used to geolocate the schools in 2008 using the unique identifier. To include new schools built between 2001 and 2008, we used a dataset provided by the Fundação SEADE (São Paulo State Agency for Statistical Analysis) containing the geocoded location for all state administration schools in 2008. The final dataset set was obtained merging these two datasets using the standard ID used by the INEP. We geo-localized a total of 4612 public schools in the SPMR.

The second source was the 2010 Population Census of Brazil, compiled and freely distributed by the Brazilian Institute of Statistics (IBGE). We aggregated the data by 633 *Áreas de Ponderação Espacial (AEP)*, a spatial unit defined for surveying purposes by IBGE. IBGE provides geographical datasets containing the boundaries of these areas. From the census microdata, we draw data on the number of inhabitants by age for each enumeration area, which totals 1,216,611 individuals of secondary school age (15–18 years), accounting for approximately 13% of the population.

The final source of information was derived from the Google

[1] Public provision of safe walking and cycling infrastructure and bicycles are areas of research worthy of attention beyond the scope of this paper.

[2] See https://developers.google.com/maps/documentation/distance-matrix/.