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Designing incentive packages for increased density and social inclusion in the neighbourhood of mass transit stations

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ABSTRACT

Local and central authorities have long been interested in taking advantage of investments in mass transit to achieve more sustainable urban development. In the case of Santiago de Chile, a highly income-segregated metropolis that also suffers an increasing urban sprawl, its underground (Metro) and BRT corridor networks offer a unique chance to revert these malaises. In effect, Santiago's modern transit infrastructure is undercapitalized, there are many areas with little or no development in the vicinity of Metro and BRT stations that could be densified providing housing to the growing population, and hopefully even turned into sub centres with urban equipment, servicing the poorer areas, thus diminishing social and spatial segregation.

We sought to understand and measure how different government incentive packages could attract private investment into such areas. We used a combination of stated choice and best-worst scaling data to examine the potential power of various government grants to encourage density development, including social integration, at these locations. Our results allowed us to identify a typology of urban areas that respond differently to the incentive packages. The differentiated analysis of the urban areas, their tendencies and perception of potential real estate developers is a significant first step to design *ad hoc* strategies to encourage sustainable development in the surroundings of Metro and BRT stations.
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1. Introduction

Santiago de Chile, a 6.5 million people city, has been experiencing two related and damaging urban phenomena: an accelerated territorial expansion and a strong spatial segregation between different income groups. Both historical trends were strengthened by the governmental social housing policies of the last 30 years, which in the pursuit of quantitative goals delegated the construction of social housing to private real estate developers, which in turn encouraged competition for lower costs with little or no consideration for the quality of houses or neighbourhoods. Construction costs were reduced through the urbanization of peripheral, cheaper land, effectively diminishing the housing deficit, yet creating a new type of urban poverty (Ducci, 1997; Mattos, 1999; Hidalgo, 2007; Sabatini & Arenas, 2000; Sabatini, Edwards, Cubillos, Brain, Mora, 2010). The Santiago of the new millennium reaches almost 50 km from north to south, with higher income people located in rich and well-serviced areas, while the more vulnerable lower-income people live in socially homogeneous peripheral dwellings, distant from employment sources and lacking appropriate urban services and equipment.

The social segregation of the city impoverishes and socially degrades its inhabitants; the isolated poor areas tend to get poorer in spite of costly programmes of improvement for these neighbourhoods. This “new poverty” scenario (Rodriguez & Sugraynes, 2005) is characterised by “those with a roof”, that is, beneficiaries of social housing programmes, provided with a roof, but still living under degraded conditions. In fact, many of such areas are becoming ghettos with relatively high indices of drug and crime occurrences, and low scholar attendance (Sabatini et al., 2010; Sabatini & Brain, 2008).

Unfortunately, the state's social housing policies have not explicitly related urbanization with the construction of the city's

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main mass transport network, which in Santiago has been traditionally sub utilized. Nor has the construction of public transport infrastructure been accompanied with mechanisms pursuing urban integration goals, such as a better social mixture or higher densities in inner areas. The surroundings of Metro and bus rapid transit (BRT) stations have a great potential for developing mixed-income housing projects and urban centralities that could provide services and equipment to several neglected areas, which in turn would greatly increase the city sustainability. This is particularly relevant in an extended city with such high social segregation (Hidalgo, 2007; Sabatini, 2000), where a good, reliable and affordable transport system could make the difference between been integrated, or not, to its economic and social life (Cervero, 2011). In fact, a recent government study found that the Santiago periphery has the highest density in the city (MINVU, 2013); in contrast, the surroundings of several Metro stations (a system with more than 40 years of existence and expected to increase 20% by 2017), have fairly low densities presenting a densification potential that could cover the city's expected growth for the next decade (MINVU, 2013; CChC and OCUC, 2013). Further, Santiago features also over 100 km of BRT corridors (with less than ten years of existence and expected to double in 2018), the surroundings of which show no dynamism at all in its development.

Under this context, a short consultancy project for the government (DICTUC., 2014) examined the willingness of real-estate agents to develop mixed-income housing around ten carefully selected Metro stations. The results showed that demand or supply oriented incentives could have differential impacts depending on the station where they would apply. But it was also clear that the respondents (i.e. private developers) felt strongly against developing mixed-income housing projects.

Based on the above results, a three-year research project was formulated with the following objectives: (i) to detect the real-estate developers' willingness to accept incentives for socially integrated density developments in the vicinity of Metro and BRT stations and (ii) to design tailor-made incentive packages for mixed housing developments in different areas of the city. We used a combination of stated choice (SC) and best-worst scaling (B/W) data, and used these to estimate fairly sophisticated discrete choice models.

The rest of the paper is organized as follows; section two briefly reviews the basics of our modelling approach and section three the relevant mechanism of incentives to the private sector used to achieve social integration. In section four we describe our data bank; the survey design, the attributes considered, the choice process and the data analysis. Section five discusses the estimated models and our main results. Section six presents some practical policy applications of the models and, finally, section seven summarizes our main conclusions.

2. Methodological framework

In its simplest form, the random utility framework assumes that individuals (q) have perfect information about all alternatives (i) and its attributes (x), and choose rationally their preferred option; however, only part of these attributes are known (or can be measured) by the modeller who is an observer of the system (McFadden, 1974). Thus, the modeller is forced to postulate that the individual's utility functions have two components: (i) a systematic or representative part V_{iq}, which is a function of observed or measurable attributes and (ii) a random component ε_{iq}, such that (Ortúzar and Willumsen 2011, Chapter 7):

$$U_{iq} = V_{iq} + \varepsilon_{iq}$$

and different models can be formulated considering different assumptions for the errors ε_{iq}. The representative utility V_{iq} is usually represented through a linear function, such as:

$$V_{iq} = \sum_k \theta_{ki} x_{ikq}$$

where θ_{ki} are parameters (marginal utilities) to be estimated. The simplest assumption is that the ε_{iq} distribute independently and identically (IID) Gumbel with zero mean and variance σ. In that case the probability that individual q choses alternative i is given by the well-know multinomial logit (MNL) model (McFadden, 1974):

$$P_{iq} = \frac{e^{\lambda V_{iq}}}{\sum_{j \in A(q)} e^{\lambda V_{jq}}}$$

where the scale factor $\lambda = \pi \big/ \sigma\sqrt{6}$ can not be estimated independently of the parameters θ and the model requires normalizing it to one. Some limitations of the MNL model are not allowing for correlation among alternatives, heteroskedasticity and random taste variations (i.e. parameters are fixed for all individuals); also the model does not allow for correlation among the various responses of each individual if they are available (Train, 2009). Notwithstanding, the modeller can parameterize the coefficients of the attributes as a function of characteristics of the individual or context (i.e. systematic taste variations, Ortúzar and Willumsen 2011, p. 279) as in $\theta_{kiq} = \theta_{ki} + \sum_m \theta_{kimq} x_{m,q}, \ \forall\ k, i, q$, where m corresponds to the context or individual characteristic.

All the above limitations of the MNL are resolved by the Mixed Logit (ML) model, which is a highly flexible function but more difficult to estimate and interpret (Train, 2009). One of its possible forms is the *error components* (EC) model, which includes an extra error component, η_{iq} (with a distribution selected by the modeller depending on what she is trying to explain), multiplying a vector Y_{iq} of attributes unknown to the modeller, as in:

$$U_{iq} = V_{iq} + \eta_{iq} Y_{iq} + \varepsilon_{iq}$$

This allows representing correlation among alternatives, correlation between the responses of a given individual (i.e. panel effect), heteroskedasticity and, even, endogeneity in data mixing – for example – stated choice (SC) and revealed preferences data (Train & Wilson, 2008). In the case of SC data, individuals are faced with a series of hypothetical situations comparing, typically, two alternatives defined on the basis of packages of attributes, and must choose the preferred one in each case; this allows the modeller to get more than one choice per respondent. SC experiments also allow studying alternatives not existent in the market (Ortúzar and Willumsen 2011, Chapters 3 and 8).

Discrete choice model estimation may combine data from several types of responses (i.e. SC and RP) but also best-worst scaling[1] (Louviere & Swait, 1997). In this case, individuals are asked to choose the best and worst attributes (with defined levels) within a given package, revealing their relative preference order over each combination of attributes and levels. This allows estimating, in principle, both the inherent importance of an attribute as well as that associated with the variation in its levels (i.e. scale). Note that when using SC data alone in estimation, an attribute may be considered insignificant if its levels do not vary enough over the choice profile.

SC methods have been widely used in transport and marketing, for example, to evaluate a new transport mode currently

[1] The interested reader may find more details about the best-worst scaling approach in Louviere and Swait (1997) and Marley and Louviere (2005).

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