TRANSPORT SUPPLY AND DEMAND. PERCEIVED VERSUS EXISTING PUBLIC TRANSPORT SUPPLY IN SANTIAGO DE CHILE

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ABSTRACT

To plan public transport supply, the understanding of people's travel behaviour and mode choice decisions is indispensable. One of the dimensions of this understanding has to do with the perception of the actual supply, in other words, how good and accurate is people's knowledge about the concrete features of transport supply, such as locations of transit stops, timetables and fare structures. This paper explores the eventual gap between perceived and real walking distances between stops and people's residences. With data from a home-based mobility survey conducted in 2009 in 2000 households living in the metropolitan area of Santiago de Chile, which included a question inquiring people's knowledge about the public transport supply close to their places of residence. The answers pointing out the perceived supply are superposed with the real supply measured using GIS. Then a new variable was built with 3 categories: 'correct estimation', considerable 'over-estimation' and 'under-estimation' of walking distances. To observe the main determinants that influence people's perceptions of walking distances to transit stops, descriptive analysis and logistic regression are performed.

The comparison between the real and perceived supply shows a considerable gap. While local bus services are frequently underestimated, metro and trunk line services are rather overestimated, i.e. walking distances are perceived as significantly shorter than they actually are. These results vary depending on the communes. The results of analysis indicate four different interrelated aspects which seem to influence people's divergent perceptions: (1) the total door-to-door travel time, (2) the societal reputation of the various modes 'metro', 'trunk bus' and 'local bus', (3) the nature of the built environment, as well as (4) the frequency of actual mode use. Addressing these factors could be crucial in order to enhance transit ridership and open a wide research agenda for the travel behaviour field.

Keywords: travel behaviour, perceived distances, public transport

INTRODUCTION

Public transit is a key public policy for today's cities. Indeed, it is an important element for local development policy, since it tackles the mobility needs of the population, especially those without any access to alternative modes. Besides, it represents a potentially powerful tool to face urban problems such as congestion and pollution.

Despite the important role of public transport for achieving sustainable development in today's cities (i.e. to tackle congestion, environmental and social issues), this mode is often underused and considered as hardly appropriate to face people's mobility requirements. In some countries, it is a common place to consider public transport as a transport mode made "for the poor". Sometimes, this affirmation derives from a pretty objective assessment of transit provision quality which in some cities could be actually labelled as "disastrous". But it can respond to subjective perceptions of service quality that in some cases could not fit to actual system features. Indeed, lack of acceptance is on the one hand ought to actual quality and functioning problems, on the other hand also to a bad reputation and misperception by the population.

For supply planning, the design of an adequate network and efficient exploitation is crucial. Nevertheless, in order to guarantee and enhance patronage, the understanding of people's travel behaviour and mode choice decisions is also needed. One of the dimensions of this understanding has to do with citizens' perception of the actual supply, or in other words, how good and accurate is people's knowledge about the concrete features of transport supply, such as locations of transit stops, timetables and fare structures.

While planning authorities put emphasis on the functional improvements of the supply, they risk neglecting the challenge to improve users' perception and general of public transport of inhabitants. Operator companies themselves sometimes carry out studies dealing with the clienteles' perception about their services, but hardly develop strategies in order to correct misperception and to fill the gap between actual and perceived supply Rietveld (2010). Moreover, they rarely act on the negative image of public transport among non-users, in order to increase patronage and profitability of services. This could be the case of perceived distances to public transport stations which the literature mentions as one of the major factors to explain modal choice (Commins and Nolan 2011; Escobar, Tudela, and González 2009; Paulley et al. 2006).

This paper addresses this dimension, with a special regard to the case of Santiago de Chile. Given the fact that this city developed recent dramatic changes in its public transport supply, Santiago offers an attractive opportunity to analyse people's perceptions, attitudes and habits related to public transport system. Based on a GIS information tool, the paper compares the perceived accessibility with the actual supply of network nodes (in form of bus and metro stations) in the residential environment. For this aim the study is based on data originating from a household survey, carried out end of 2009 in five of 37 municipalities of the metropolitan area of Santiago.

Given this, one of the main contributions of this paper is to empirically address one topic transport and travel behaviour literature has not paid enough attention to. Additionally, adopting a quantitative strategy allows the authors to measure the perceived-actual distance gaps and to explore some factors to explain it. Finally, this paper brings up an infrequent approach to the specific topic of perceived distances: empirical assessment in real urban environments. In our opinion, experimental studies working with a small number of persons belonging to very similar settings (generally undergraduate students on campus) have made essential contributions to this area. We believe though that it necessary to count on empirical evidence on interviewees from heterogeneous urban settings and regarding their actual spatial position and actual network supply. The data suggests that perceived distances fit quite accurately to actual distances and that the main differences have to do with transport mode, as long as the main differences stands for perceived distances to metro stations. Nonetheless, some differences do exist and they may influence potential ridership and patronage. Indeed, the stations of the less reputed modes (i.e. trunk services and specially feeder / local bus services) are perceived as further than the actual locations, whilst the well reputed mode of the metro is mostly perceived as much closer (and easier accessible) than it actually is. In that sense, to know better about this issue is relevant for understanding modal choice and to have more sustainable urban transport systems.

The subsequent paper consists of four basic parts. After having exposed some theoretical findings on travel behaviour and mode choice decisions as well as the role of variables such as personal habits and experiences (section 2), the research hypothesis and methodological approach are explained (section 3). In section 4 the case study area of Santiago is introduced, taking into account the general social and spatial structure of the city as well as recent transport developments, in order to then focus on the concrete survey results. Finally (section 5), the paper concludes, pointing out the need for further research and proposing some derivatives for appropriate public transport planning and policy making.

THEORETICAL FRAMEWORK

The theoretical background on the specific subject of the gap between perceived and actual distances to transport network is pretty scarce. Mc Cormack et al. (2008) unfolds a key research work for our paper. The authors study exactly the concrete discrepancies between objective and perceived distances to a number of destinations (including distance to train stations). Using a very similar methodology to the one adopted in this study (GIS location of dwellings and destinations or services) they try to understand the influence of socioeconomic characteristics (age, gender, physical activity) and the built environment (land use mix, intersections and dwelling density)[1]. They find that most people tend to overestimate distances and that in general, trips that are done regularly seem to increase the likelihood of overestimation whilst irregular trips are rather underestimated. The same takes place regarding walkability: people living in areas with high walkability (strong land use mix, high densities, more intersections) tend to overestimate walking distances, while residents of areas with low walkability rather underestimate actual walking distances. They also find only slight influence of socioeconomic indicators such as gender and age.

Furthermore, several studies on travel behaviour and modal choice, spatial syntax and spatial behaviour tackle –not as a central issue- some dimensions of the topic. For this reason, it is

[1] Even though the methodology and objectives are quite similar, this study addresses issues such as physical activity and walking habits and not travel behavior and mode choice at all.

worth paying attention to some pieces of literature on travel behaviour and mode choice that is related to the discussion of this paper. This discussion points out perception versus actual supply of public transport as a relevant issue in order to understand modal choice.

The gap between actual and perceived supply of public transport refers to a wide array of aspects, such as frequencies and headway regularity, travel comfort, waiting times outside of vehicles, access and egress times to and from the stops, reliability and punctuality of services, vehicle occupation as well as availability of seats (Rietveld 2010). This author calls the attention to the fact that planning stakeholders mostly lack of reliable and updated information in order to integrate a "misperception-factor" in their modelling and design procedures. For instance, it is today a common fact waiting time outside of the vehicle and spent on mode transfers is perceived as double as actual travel-time in the vehicle (Munizaga et al. 2008). Nevertheless, conventional transport demand models still often neglect this fact, which affects the over-estimation of actual demand and ignorance of user dissatisfaction. Related to this, we still find many transport demand models in use, which are based on average door-to-door travel times, neglecting possible delays. Delays become particularly problematic for the users, if trips include missed mode transfers in a system without a regular interval timetable (Kaufmann et al. 2009; Rietveld 2010). While regular interval timetable guarantee prompt connections and provide service guarantee within a fix time period, delays in a system based on irregular frequencies might cause uncertainty and stress for public transport riders (Kaufmann et al. 2009). Another striking example of supply misperception refers to people's estimation of vehicle occupancy. So could be shown that travellers' previous experiences influence the perception of vehicle occupancy in a significant way. People riding normally the bus during peak hour perceive generally higher occupation rates than people exclusively using the bus off-peak (Rietveld 2010).

The importance of previous experiences of transport users in the context of actual perception and satisfaction has been subject to many studies (Flamm, Jemelin, and Kaufmann 2008; Flamm and Kaufmann 2006; Van Acker, Van Wee, and Witlox 2010). So can we distinguish between *reasoned influences* on traveller's behaviour and mode choices, such rational, time-related restrictions, but also individual preferences and attitudes, as well as *unreasoned aspects*, dealing with hardly reflected influences such as long-lasting habits and spontaneous impulsiveness (Van Acker, Van Wee, and Witlox 2010).

A comprehensive explanatory approach is given on this issue by van Acker et al. (2010), who explain travel behaviour as results of a hierarchical decision structure (Salomon and Ben-Akiva 1983), where short-term decisions related to travelling and daily activities are based on the one hand on longer-term decisions such as residential location and lifestyle choices. On the other hand, the temporal hierarchy of these *individual decisions* is embedded into a specific *social* and societal environment which itself is again conditioned by the *spatial and built* environment. However, different temporal and contextual levels or domains form together a very complex construct of influence factors where the resultant individual decisions on activities and travelling form the core of interest. In the frame of the present paper central emphasis has to be put on the distinction between so-called "*reasoned" influences* on the various decision levels such as individual perceptions, attitudes and preferences and so-called "*unreasoned*", i.e. hardly reflected, influences including habits and impulsiveness. Van Acker et al. underline that the conglomeration of these two domains allows explaining different behaviour structures of individuals, even if the individuals form part of the same spatial and social context.

While in conventional transport planning procedures, the emphasis is put on people's rational decisions, in the last years mobility-research has attracted more and more interest. Indeed, in traditional transport research behaviour is understood as result of rational choices by an individual. According to the Theory of Planned Behaviour of social psychology, these choices are made on the basis of the categorization, transformation and interpretation of some kind of stimulus (e.g. an object or issue such as travelling) as well as a resultant perception of this stimulus (Golledge and Stimson 1997). The sum of this process is defined finally as attitude, for instance towards a specific transport mode. Nevertheless, social psychology points also out attitudes as centrally influenced by *cognitive* and *affective* aspects. Thus, differences in the cognitive and affective perception of a transport supply may form two central reasons for individual behaviour differences and hence, obstacles for exact transport behaviour estimation and forecasting tasks.

The importance of these two items in the transport domain have been recognised in many other studies and given birth to theoretical concepts such as the motility concept by Kaufmann (2002). Kaufmann points out the individual prerequisites of competences and skills in addition to temporal and spatial access in order to become spatially – or also socially - mobile. Moreover, a third dimension is included which is defined as "appropriation" or simple as the transport project itself, as result of the person's interpretation of access and skills in the context of a specific travel end. Again, the appropriation domain is mainly shaped by individual aspirations and plans and originates from the person's values, perceptions and habits. Based on the motility concept, Flamm (2003) identifies finally four dimensions of individual decisions related to travelling or "becoming mobile". In additional to the practical and cognitive dimensions there are also the *symbolic* and *affective* ones, again according to the findings by social psychology mentioned above.

Furthermore, in a common study on the operationalisation of the motility concept Kaufmann and Flamm and Kaufmann (2006) underpin the high significance of *habits* in travel behaviour, according to the theoretical approach by van Acker. As example they mention the "rejection by principle" of specific modes such as public transport and suggest the string influence of a person's experiences (or lack of experiences and effective use) of these modes during childhood. This is a key variable according to our approach because mode perception could be part of the past experience necessary to estimate distances to bus stations.

Regarding "mode reputation", note that misperception doesn't necessarily refer to a worse perception of actually good supply. It might equally refer to the ignorance of effective deficiencies of transportation features, due to people's good image and previous experiences with this transport system. Anyway, the unawareness of problems and drawbacks related to transport mainly refer to the use of private motorised modes. There are some studies who detect the ignorance of car-related problems such as higher costs, pollution and congestion, and the on-going role of a private car as status symbol (Witter 2012; Kaufmann 2003; Jemelin et al. 2006). On the contrary, public transport services are rather criticised more than necessary, and hardly perceived as better than they actually are. In the same vein, as we posit in this paper, modes with good overall reputation among users will be evaluated much better in all dimensions (e.g. stations distances) even when this is not accurate. Thence, if a transport mode presents several positive attributes, it is plausible that other attributes including distance to stations "take advantage" of overall assessment and the outcome is that perceived distances are shorter than the actual ones.

In that sense, Alshalalfah and Shalaby (2007) explore the relationship between walk access distance to transit and various characteristics of the transit service and transit users in the city of Toronto, Canada. They consider that quality of service is one of the most important variables regarding willingness to walk. Indeed, they find that people in Toronto are willing to walk further to get to routes which frequencies are higher. The higher the frequency of the transit service, the longer people are willing to walk to access transit. It is plausible that if riders are willing to walk further to access these routes, they also would tend to perceive distance to stop to these services as more walk able. The authors' evidence also states the same situation for metro services regarding bus and street cars. People tend to walk on average 100 additional meters to get to the stations, even when almost 8 out of 10 dwellers have transit services around 500 meters. Our argument is consistent with this evidence. If people are willing to walk further to metro stations than to bus-street cars, they will conceive metro stops being closer than they really are, either because they are willing to "pay" a physical energy surplus to get to a better quality service or because the overall quality spreads to other attributes such as walking distance to the network.

Rietveld (2010) is of particular interest for the purpose of this paper as the author specifically tackles the differences between actual supply and perceived supply by a transport system's users. In this context the role of quality-indicators such as frequencies / headway regularity, travel comfort, waiting times outside of vehicles, access and egress times to and from the stops, reliability and the guarantee of "arriving on time", also in case of mode shifts and transfers between modes as well as availability of seats are said to be typical examples where the suppliers' view may significantly differ from the user's point of view. As main reasons for this gap is mainly seen the lack of available reliable information and data (see Munizaga et al. 2008). The author underlines the finding that the perceived occupancy rate of a vehicle is effectively influenced by the travellers' previous experiences, affecting that people riding normally the bus during peak hour perceive generally higher occupation rates than people exclusively using the bus off-peak. Though this paper is a very good sample to know better on the actual/perceived supply gap it does not mention the perceived distance to the stations. However, it contributes with several theoretical insights that could be considered in order to understand distance perceptions. In our opinion, one of the most relevant factors raised by the author is the consideration of previous experience using a particular transport mode. It could be argued that the experience using a mode could be extended along several dimensions. Thus, if the headway is irregular and the speed slow, the person will also perceive that the distance to the station as a long walk, even longer than the actual distance.

So far, most of the reviewed literature deals with the relation between the built environment and travel behavior, specifically mode choice. Some pieces of research address the effect of the built environment on more general spatial behavior. In this case, the conception of built environment refers to its geometric aspects, such as the number of intersections and axes in a given neighborhood or block (i.e. the street grid). On the one hand, this literature is very useful as it specifically tackles the distance perception issue. On the other hand, these studies are not directly related to transport issues because as long as they do not consider public transport features as relevant factors as we do in this paper.

Cognitive sciences posit that a network effect exists, this is that geometric and topological properties of the network influences peoples distance perceptions (Hillier and Iida 2005). These authors set up a model that considers the influence of three different "distance-definitions" on the results of human movements' simulations. Applied by data in four different areas of London, model results show that for both, vehicles and pedestrians, the definitions based on least angles and least turns turn out to be the best predictors of movements (and not the "shortest path"). This is an example of how "built environment" – taken in a narrow definitions deeply embeebed in street grid features- shapes distance perception and movement decision (see also Y. O. Kim and Penn 2004; Y. Kim 2001; Bafna 2003).

In the same vein, the «turn-intersection –theory» (Sadalla and Staplin 1980), also known as route-segmentation theory proposes that the larger the complexity of a given path (e.g. number of intersections and angles) the longer the distance between an origin and a destination is perceived. In a few words, a trip including two intersections is perceived as shorter than a trip (of the same length) including six intersections. The « feature-accumulation-theory » is a contender one (Crompton 2006). The latter proposes that perceptions are done on the basis of experiences. Thus, in isolated spaces the lack of experiences leads to misinterpretation and misperception. More in detail, the feature-accumulation theory, which the authors of this article support, suggests that a more vivid an environment is the shorter is perceived a distance to walk in this environment. On the other way round, the more isolated an environment is, the more probable is the over-estimation of walking distances.

Moreover, trips which are repeated regularly over a specific time period are perceived as longer, since the environment is less interesting. This way, Crompton (2006) makes a case set a discussion regarding these two theories and confirm findings of Lee (1970). After developing an experiment, he gathered evidence that supports Lee´s finding in the sense that people who use the same path year after year perceived it as longer. Lee (1970) argued that perceived distances are a function of direction. This is that, other factors being equal, inward city trips are perceived as shorter than outward trips. This author also identifies a "decreasing factor" of overestimation, since for very long distances the proportional overestimation factor decreases.

RESEARCH INTEREST AND METHODOLOGICAL APPROACH

The research question of this paper are twofold: how accurate is perceived distance to transit stops or stations and which factors are associated with the gap between actual and perceived distances whenever a gap –in one or another direction- exists. Additionally, perception has proven to be a relevant factor regarding travel behaviour and mode choice. The perception of service quality is essential regarding mode choice and transport sustainability within an urban system. As it is shown in the reviewed literature, quality perception of the service may vary even for the same actual conditions, causing not always rational or sustainability oriented individual and aggregate decision-making processes. Thence, one could argue that these questions are framed in two broader issues that include them. The first is to comprehend how people know and inform about the supply and their travel options. The second one has to do with people's travel options and how do they make use of them.

Back to the particular research questions, theoretical insights from travel behaviour, mode choice and psychological theories suggest that it is necessary to take into consideration a wide array of factors to explain the gap between perceived and actual distances to bus stops. Firstly, some variables arise regarding peoples' attitudes and habits, the so called reasoned and unreasoned variables. The built environment is also mentioned as an important factor to account for, either for its geometrical and topological characteristics or because the effect on an individual perception through feature accumulation that motivates willingness to walk. We posit that perceived overall quality of service of a given mode also plays a role when people assess distances from their dwellings to the network. If a person perceives that metro provides high quality service, it is plausible that he or she will perceive the walking distance to the station as shorter than it actually is.

That's why we suggest in the present paper to have a deeper focus on the perception of walking distances to public transport (bus and metro) stops in the metropolitan area of Santiago de Chile. Thence, in line with the research questions posed above, the objective of this paper is to describe how well people who live in the studied districts perceive the actual provision of public transport network. Once the description is set, the second objective is to explore which variables affect this gap and in which direction. Namely, we are asking the plausibility of valid hypothesis for further research on the topic.

In order to fulfil the research objectives, the empirical evidence was gathered through a 2009 mobility survey carried out in 2000 households in 5 (out of 37) districts of Santiago de Chile. These districts include the most significant centrality in the city –including the city CBD- and representative samples of periphery low income communes as well as affluent households sectors. By the same token, the selected territories present a wide array of scenarios regarding public transport supply, either metro or bus services[2].

To build the "dependent" variable it is necessary to overlap two measures of distance: the perceived one and the actual one. The former -perceived walking distance to metro and bus stops- is revealed through a question about each mode stations availability around 400 meters (or "within 4 or 5 minutes walking"). The answers pointing out the perceived supply are superposed with the real supply measured using GIS (aerial distance to metro stations and bus routes). Then a new variable was built with 3 categories: 'correct estimation', considerable 'over-estimation' and 'under-estimation' of walking distances[3].

To observe the main determinants that influence people's perceptions of walking distances to transit stops, descriptive analysis is performed. Accordingly to the theoretical framework, three dimensions are discussed in this paper: individual and socioeconomic features (age and

[2] This survey was originally designed and collected for the purpose of the research work published in Witter (2012).

[3] A 100 meters mis-perception was accepted. Thence, if a person answered that he does not have a bus stop within 400 meters, to be classified as "under estimating" supply, the stop should be under a 300 meters area of influence. Reversely, to "over-estimate" a person should declare availability of buses but being at least 500 meters away from the closest route.

gender), transport mode and mode choice habits, and built environment (synthesized in the variable district).

CASE STUDY AND RESULTS

The case of Santiago de Chile

The metropolitan area of Santiago de Chile comprises 37 boroughs or municipalities with approximately 5.5 million inhabitants (2002 census), spread over a surface of 76,000 hectares. Morphologically, the city is characterized by a rather mono-centric-radial structure with the traditional central business district (CBD) in the central (homonymous) municipality of Santiago-Centro and radial transport axes, connected by a privately run ring road highway. In addition, in the last decade, a second economical centre emerged in the affluent cone of wealth in the eastern part of the city, which has gained increasing economic dominance over the traditional CBD (Witter and Hernández 2012).

The public transport network components are a vast bus network with trunk services composed by high-capacity articulated buses that serve routes along the city and feeder services which are displayed for local areas. It also includes subway services (5 lines) which work under a tariff union schema with buses. Buses system went through a serious crisis after the implementation of a new reregulated system known as Transantiago. This system was an ambitious failed project aimed at providing high quality, cost-effective services but after a abrupt start it immediately provoked an actual chaos in the city (for information on Transantiago project see Witter and Hernández 2012; Figueroa and Orellana 2008; MUÑOZ and GSCHWENDER 2008a; MUÑOZ and GSCHWENDER 2008b; Witter 2012). That is one of the reasons why buses systems are really unpopular for the population. Meanwhile, the metro enjoys a very positive reputation. The tariff union brought a lot of new users –actually this is one of the most positive effects of Transantiago project- that generated very high metro occupancy which make it become much more crowded than usual, especially during peak hours. However, this mode is still evaluated as provider of fast and reliable service.

Perceived and actual distances

To begin with the empirical analysis, in this section we describe the actual and perceived distances to the network from households in the survey sample. First, in table 1 the actual distances to trunk buses routes and metro stations are depicted. The data is pretty straightforward: in the case of trunk routes the network extension and density is extremely high. This leads to the fact that in 4 out of the 5 studied districts at least 92% of the interviewee households have a trunk route around 400 meters. Puente Alto commune constitutes an exception in which only a third of households in the sample within the service area.

Table 1. Network coverage (400 mts service area) and average actual distance to network by district and mode. In percentage and meters.

	Bus (trunk) route around 400 mts.	Average euclidian distance to trunk route	Metro station around 400 mts.	Average euclidian distance to metro station
Las Condes	91,9%	202	3,5%	3073
Lo Espejo	96,0%	172	0%	2869
Maipú	95,3%	166	0%	6908
Puente Alto	31,2%	629	2,9%	1958
Santiago	99,9%	56	20,2%	908

Source: authors' own calculations.

As with the service area, the average distance to a trunk route also reflects that it is a very dense network with a high coverage. In three districts the average distance holds between about 160 and 200 meters. At the highest endpoint, Puente Alto has more than 600 meters of average distance, whilst Santiago has the more dense network supply with, on average, about 56 meters from each household in the sample. Note that Santiago is still the most important urban centrality in which governmental, economical and political resources locates. Moreover, a relevant portion of urban routes –especially trunk routes- pass through this district or they even have their endpoint there.

Regarding metro network supply, it is almost the opposite situation to buses network. Indeed, it is clear that it is a network with a lower density and that it is not spread through the city as in other urban agglomerations. Two districts do not have any household within 400 meters when the data was collected[4]. Puente Alto and Las Condes have only about 3% of households within a 400 meters buffer from any metro station. Santiago is the only district in which a pretty dense metro network exists. Similarly to the buses network density, its central role in urban life explains this fact. Nevertheless, as a result of the configuration of metro stations, the percentage of households is still low (20%). Moreover, the actual average euclidian distances are almost 20 times the ones for trunk services.

Given this data, the first limitation arises as some scenarios will have to be discarded. As a matter of fact and for logical reasons, we will not find under-estimation of metro services in Lo Espejo and Maipu and to hardly find it in Las Condes and Puente Alto. Because of the same reasons, it is unlikely to find over-estimation of buses supply for all the districts except for Puente Alto. Having said that, in the next tables and charts both supply measures –actual and perceived- are depicted.

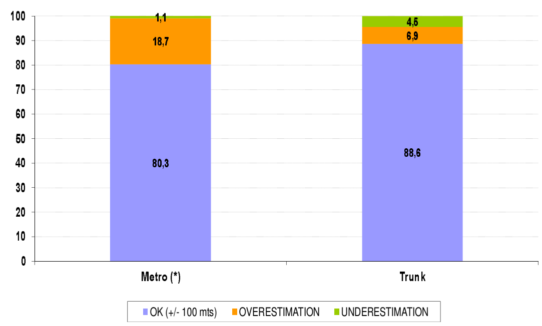
In the next chart we present the overall percentage of correct estimation, overestimation and underestimation of metro station and trunk buses routes. It has to be noted that these figures includes the five districts which –as showed before- are very different regarding each mode actual supply. Despite these differences, the relevant fact to point out is that at least 8 out of 10 persons "correctly" answer to the question about bus and metro supply in his

[4] The extension of one of metro routes nowadays gets to the district of Maipu.

neighborhood. The data indicates that people are aware of the existence or absence of public transportation supply and are able to estimate distance regarding a given distance threshold. As expected, the percentage of metro overestimation is higher than the one for buses since the former network extension is smaller than the latter. This fosters the potential for overestimation when answering the question.

To some extent, it indicates that people are responsive to actual supply. Accordingly, it could be argued that they will be responsive to changes in quality of the service. At least they will be responsive in terms of awareness of these changes, regardless of changes in their behavior that could cause.

Chart 1. Overlapping between actual and declared distances



(*) only comunas with metro service

In the next table we analyze the gap between actual and perceived supply for each comuna. By doing so, it is possible to control for the different actual supply mentioned above. For the three districts in which any type of metro supply exists, The availability of metro services is very often overestimated, which means that distances to the metro network are underestimated

For all the districts, the underestimation of metro supply is very low. As it was said it is senseless to pay attention to underestimation figures of metro in comunas in which only 3% of the interviewee lives within 400 meters of walking distance to a station[5].

[5] Remember that to be classified as underestimating the service; the person should have answered “no availability” having a station or route within 300 meters from his dwelling. This decision was taken

Nonetheless, the underestimation is also marginal in the case of Santiago district in which the actual service is relatively extended.

Regarding buses services, once again it is pointless to consider overestimation in those districts with almost full availability for 400 meters walking distance. In the case of Puente Alto (with only 31% of availability) it does register overestimation. Indeed, more than 19% of people from these comuna affirm that they have buses supply closer than they really do. Moreover, the underestimation figure is the second lowest of the five districts.

Table 2. Overlapping between actual and declared distances by mode

	METRO		**TRUNK ROUTE**	
	Overest. Supply	**Underest. Supply**	**Overest . supply**	**Underest. supply**
Las Condes	6.5%	0.3%	2.6%	1.5%
Lo Espejo	0	0	0.8%	6.9%
Maipu	3.3%	0	1.6%	6.8%
Puente Alto	14.4%	1.1%	19.4%	3.6%
Santiago	39.1%	1.8%	0	4.2%

Source: authors' own elaboration

Do figures in this table mean that overestimation of metro or buses services are just an artefact of the actual supply? In other words, that people overestimate (when network is not extensive as the metro) or underestimate (when network service is extensive as the buses) as an automatic reflection? It is obvious that it is mathematically impossible to collect overestimations if 100% of the people live in a given walking distance under the adopted distance threshold. Nevertheless, we posit that the overestimation is different between metro and buses services. In fact, the latter seems to be more frequently overestimated than the buses.

To illustrate this point, we will focus in the remainder of the paper in the two districts for which a comparison sounds reasonable. The case of Puente Alto and Santiago are adequate because both of them have metro services (minimal in the case of Puente Alto) and low coverage of buses and thence potential for comparison between modes. Unfortunately built environment in these comunas are pretty different. Santiago is a typical urban "walkable" setting with high dwelling density and mix land use. On the contrary, Puente Alto has less density and mix land use.

The next table synthesize the amount of overestimation regarding actual supply for the cases in which it exists: bus and metro in Puente Alto and metro in Santiago. It presents in the upper side of the table the data on actual and perceived distances to both networks. The overestimation as a percentage of the actual supply is higher in the case of metro service regardless of the district. In Puente alto, the "total" metro supply is more than five times the actual one. This is, that with a very limited service at 400 meters of walking distance, 14% of the population perceives that they count on metro service on that distance. In the case of

to be more categorical about the misperception. Nevertheless the difference between this measure and the one taken with precise 400 meters are minimal.

Santiago, even when the percentage of actual metro service is 20%, the overestimation still almost double it, getting a “total supply” of almost three times the actual service.

Meanwhile, for the case of buses overestimation, the figures are much lower than the ones for the metro. The “total supply” in this case is about 1.5 times the original one. Thence, it is possible to speculate that metro as a mode tends to maximize supply overestimation.

Table 3. Actual and overestimated supply and actual distances to service of people who overestimate service. Santiago and Puente Alto.

	Puente Alto Metro	**Santiago Metro**	**Puente Alto Trunk buses**
(a) Actual supply	3	20	31
(b) Overestimation	14	39	19
(c) Underestimation	1	2	4
“Total” supply (a + b – c)	16	57	46
Actual distances persons who overestimates			
Media	1076	1103	776
Quartil 1	669	765	603
Median	878	1091	778
Quartil 3	1325	1368	922

Source: author’s own elaboration

The remainder datain the table refers to the actual distance to metro and buses services from dwellings of people who overestimate each mode supply. In short, people from Puente Alto who ansewered yes to question "Is there a metro station within 400 meters” whereas any station exists in a 500 meters area service is, on average, 1076 away from closest metro station. To some extent, this distance sets a threshold of “willingness to walk” to a metro station since they perceive it as a very close one.

It is interesting that meanwhile metro overestimators are on average about 1100 meters away from the closest station, for overestimations of buses in Puente Alto that figure decreases to 780 meters for buses. One of the reasons is that trunk routes in Puente Alto are, on average closer than metro stations. Nevertheless, the relevant question is whether trunk routes had longer distances, would people who overestimate increase that threshold. By the same token, it is plausible that people would not underestimate walking distance to metro after 700 meters, but they did. Those questions will remain unanswered, but evidence suggest that metro’s threshold to willingness to walk (i.e. perceive as a 400 meters walking distance longer ones) is higher than buses’ one.

Regarding the factors associated with a correct estimation of public transport supply, to explore some of the factors associated to distance and supply perception, we will run a logistic binary model with the composite actual-perceived as the dependent variable. More specifically, we will focus on the overestimation of metro supply in the distric of Santiago.

This technique applies maximum likelihood estimation after transforming the dependent into a logit variable (the log of the odds of the dependent occurring or not). It estimates the probability of a certain event occurring. For this study, the predicted variable is related to the occurrence of an overestimation of metro supply (against correct estimation or underestimation). One of the advantages of the logistic regression is that in general it has less stringent requirements than the multiple-linear OLS regression. It does not assume a linear relationship between the dependents and the independents; the dependent variable need not to be normally distributed; the dependent variable need not to be homoscedastic for each level of the independents; and it does not assume normally distributed error terms.

The variables to include in the model are frequency of use of public transport, socioeconomic status, gender, age, automobile ownership, metro perception[6]. As we decided to focus on one commune and mode, variables related to the built environment and street topology cannot be considered. A priori, one could expect that frequency of use should be a compelling predictor for our dependent variable. To have frequent experience with a given mode –for instance walking to network stations- could grant more accurate perceptions to the persons.

How long the person has lived in the same location will be included as well. This variable will help to infer for how long people walked the same path towards public transport network. It is a proxy to explore the "feature-accumulation" theory as long as the more monotonous the walk, the longer it will be perceived. However, it also could be read the other way around because it is the central district of the city with highly dense and mixed land use and therefore with plenty of opportunities to live a vivid environment full of experiences as this theory posits. The model is complemented with metro evaluation that individual declared as a dummy variable (1= neutral positive to very positive reputation). Even when this is not a comparison between modes different supply perceptions, the more positive evaluation could lead to a more friendly perception of walking distances to the stations.

Next table presents the estimated parameters for all the predictors. It is noteworthy that the model as a whole is not significant[7]. This indicates the complexity of the phenomenon to predict. Even when for almost all variables estimated coefficients have the expected direction, only one variable is statistically significant according to Wald test.

[6] This variable is a byproduct of an open-ended question that requires the interviewee to mention 3 words that define this mode. The result is an ordinal variable with 7 categories that derives from the combination of the 3 words implications (positive or negative). For the sake of having enough cases in each category, we recoded the variable into a dummy one with two categories: negative perception and neutral-positive perception.
[7] Chi square test to logistic model : sig. 0,213.

Table 4. Logistic binary regression results

Variables in the model	B	S.E.	Wald	Sig.	Exp(B)
Age	-,007	,007	,825	,364	,993
SES (1 = affluent … 4 = poorer)	,263	,132	3,980	,046	1,301
Years in same building	-,003	,005	,307	,579	,997
Woman	,327	,238	1,891	,169	1,387
Car	,260	,245	1,134	,287	1,297
Positive evaluation	,049	,238	,042	,837	1,050
Frequency use PT	-,078	,166	,223	,636	,925
Constant	-,994	,610	2,656	,103	,370

Dependent variable: estimation of metro supply (0 = correct or underestimate; 1 = overestimate).

Indeed, the socioeconomic status is the only significant variable. In actuality, this is an obscure variable when considering the theoretical references revised earlier. It is a difficult task to interpret why the poorer the household the odds of overestimation increases. Though the inclusion of this variable responds to control for general socioeconomic background, its significance suggest that general lifestyles and mode image issues are playing a part here. It also indicates that a more “physical” variable (i.e. built environment, topological characteristics, and spatial form of the network) should be included in the model to get a better specification.

CONCLUDING REMARKS

This paper shows, first, that people present a pretty accurate perception of transport supply around their residence location. In general terms, when perceived supply does not match with the actual one, the bias is toward overestimate the actual supply by underestimating walking distance to the metro station or the bus stop.

Especially distances to metro stops are perceived as shorter than they in reality are. A generally very good image of this transportation mode, particularly in comparison with less efficient bus services, seems to have an important influence on people's underestimation of distances and over-estimation of actual supply quality. With very limited network coverage, metro services have a greater effect on perceived supply. Even when this does not necessarily means that people will switch from private to public transit, one plausible explanation is that when a good image exists, people could be prone to walk further to get to this service because they perceive distances as "walkable".

The results of a logistic regression model do not bring light to the questions on the factors that explain or determine gaps between actual and perceived supply. Since none of the proxies variables for some of the reviewed theories has a significant impact on metro service overestimation, alternative hypothesis should be posed. To better specify the model factors related to built environment may make a difference. For the model this variable was fixed as it, for practical reasons regarding actual supply and effective overestimation, only considers Santiago district.

But even more significant, the empirical evidence points to the need for further research, either through new research work with different methodological strategies or pursuing better specifications for the same data. Besides, the data itself have some limitations. First, we do not have the estimation of distance to the network, just the binary answer yes or no to a 400 meters threshold. Second, we cannot control for the actual use of the public transport service. A person could answer that there is no buses service even when there is one. Nevertheless, it could be also true that she does not use that one because those routes do not take her to where she needs to go. Thence, the data does not refer to a destination from an origin to a destination to which the person needs to reach in order to get to public transport services. For future research work, it will be convenient to study supply pieces that persons actually uses or could use.

Notwithstanding this unclearness, some discussion on substantial issues can take place. First, in contradistinction to some pieces of literature, people do not tend to systematically overestimate distances. On the contrary, regardless of the mode, when the actual supply was limited (such as the metro for all the districts or buses for Puente Alto) a portion of people overestimated actual supply, assuming that network was within 400 meters in cases in which it was much further than that. In the case of metro, the threshold below which people consider distance as walkable was higher than for buses.

This evidence could support Lee's (1970) "decreasing factor" of overestimation, since for very long distances the proportional overestimation factor decreases. Metro service location was systematically further than buses routes. That could be a reason why people keep on declaring existence of supply within 400 meters even when the closest station is more than 900 meters away.

Additionally, in line with Mc Cormack et al. (2008), traditional individual characteristics such as age and gender have a very slight effect. Finally, even when data do not help to confirm it, quality of the service as a factor that fosters overestimation of supply is still a plausible hypothesis. Empirical evidence of this paper is in line with Alshalalfah and Shalaby (2007) findings who show that people´s willingness to walk is higher for more frequent schedule's buses. There are two possible mechanisms that drive "Quality effect" on supply perception. The first is Flamm and Kaufmann' (2006) "rejection by principle" (or "compliance by principle" we would add) of specific modes such as buses. The principal role played by socioeconomic status in the model support this line. The second is a more rational argument that could be part of the *reasoned influences* on traveller's behaviour and mode choices (Van Acker, Van Wee, and Witlox 2010). Being the metro a faster public service (and more reliable in the case of Santiago de Chile) people might make a trade-off between time in the vehicle and time walking to the station. In this case, the individual should conceive the trip as a unit.

To sum up, even when the evidence is not categorical about reviewed theories, several dimension remains as plausible hypotheses for further research work that proved to be necessary. Once again, it is important for public policy discussion that it is plausible that high quality of service may change supply perception even being overestimated. It could be the first step of a long process of modal shift from private options or delaying modal shift from public transport to private modes.

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