Market shares and catchment areas to stops and stations in a multimodal public transport network

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Land use regulations are in some countries related to the access to the back-bone public transport system, typically the rail borne public transport. This means that a higher building density is allowed on lots close to stations. However, with the increasing number of types of public transport modes spanning from regional rail over light rail and bus rapid systems (BRT) to normal busses, it has been debated which sub-modes to consider being part of the back-bone system, which sizes of catchment areas are reasonable, and whether there is a “rail” effect, or it is merely the effect of better level of service (LoS). This discussion has been particularly intense in the Copenhagen Region, due to the construction of a new light rail line, new metro lines, and some (short) BRT-like lines.

1 Background

The access to public transport alternatives is important for travellers’ choice of public transport, and may influence the choice beyond the level of traditional linear level of service variables from origin to destination. The purpose of the paper is thus to empirically investigate the subject of how availability, and hence the design of the public transport system and land use policies influence the choice of public transport, within an analytic framework that control for the overall journey attributes and correlation among explanatory variables. The availability can be measured as a catchment area where travellers only consider stops and stations within a certain distance band, or the likelihood of using the public transport decrease with the distance to the service. The service of stops and stations is of significant importance for the travellers. In a multimodal public transport network, stops can be serviced by trains, bus or both but also within the train and bus categories the services can be of great difference.

In the Copenhagen Region this is important also for the reason that the present land use regulation favour urban development close to traditional rail stations within a politically defined radius from the station, since higher building intensity are allowed in these areas. The regional transit authority – MOVIA - requested DTU to make a scientific study in order to suggest better founded and more refined definitions of catchment areas (Nielsen et al., 2016).

The literature shows that travellers have a preference for public transport on rails and prefer train over bus (Eluru et al., 2012, Nielsen and Johansen, 2012, Anderson et al., 2014, etc.) and a dispreference for the access time to the public transport network (Fosgerau et al., 2007, Bovy and Hoogendoorn-Lanser, 2007, Nielsen and Johansen, 2012, Anderson et al., 2014, etc.). In many studies the access time proves to be a higher dispreference to the traveller than the in-vehicle travel time. Differences in service levels within a mode also affect the ridership (Parbo, 2016).

2 Purpose

This study thus investigates the market shares of public and models the market shares as functions of the availability of public transport in the Greater Copenhagen Area (GCA). The main purpose is to integrate both the “rail effect” (difference on passengers’ preferences for various sub-modes), the effect of catchment areas, the general Level of Service (frequency of the services, travel times) and socio-economic variables into the same empirical study and model, in order to disentangle all effects taking correlation of effects into account.

3 Empirical study and model development

The study builds on more than 26,000 trips from the Danish Travel Survey describing in details the daily trips and the characteristics of each traveller. The network of the GCA is represented in a schedule based data model containing information about all lines, runs, stops and schedules for bus and trains in the area. Start and end addresses of each trip are known, and with a geocoding of the observed trips, the accessibility of public transport can be defined and measured for each of the points. All addresses included in the study have access to public transport within 2 km (very few addresses in the GCA do not comply with this).

Logistic regression models were formulated to describe the market shares in terms of distance and service levels. The aspect of how to measure the distance from a trip end to a public transport stop was investigated in details by comparing the significance of measuring the distance as (i) bee-line or (ii) network distance and testing whether (iii) stops were considered the same within a certain distance or (iv) the increase in distance decreases the likelihood of using public transport. The various service types for bus (high-frequent, express, regular) and train (intercity, regional, suburban, local and metro) are considered and service types of are defined based on (i) the headway, (ii) the driving speed (skipping stops or not), and (iii) bus branding (high frequent A-busses, fast S-busses, etc.) and the characteristics of the stops for example (i) the headway, and (ii) the bus types serving the stop. Also a large number of socio-economic variables were accessible for the logistic regression model estimation. Based on the various models new definitions of how to measure the accessibility are suggested.

4 Results and recommendations

As expected the models shows that the travellers are willing to accept a larger travel time to a train station than to bus stops, and that they have a preference for rail all-other-things equal (the “trail” factor). However, this varied dependent on the type of rail borne service. Results indicate that a catchment area up to 1200 m can be defined for the most preferred trains (suburban, intercity, regional), where catchment areas are smaller for local trains. This suggest that a differentiated land-use policy should be used in the Copenhagen Region, where local trains (and the coming light rail) catchment areas might be added to the present land-use regulations.

For busses there was a weak indication that a small catchment area can be defined for the high-class busses (high-frequency/express) but not for the regular busses, where the ridership only was explained by the pure LOS-variables. This basically mean that a “bus is a bus” from the passenger point of view, and any branding like “A”, “S” or “E” busses or BRT does not increase the ridership beyond what is explained but the improvements of LoS (if any).

All models indicated that it is better to define catchment areas as path-searches in the local walk and bicycle networks, rather than using circular buffers, since the models with the refined path-search had a better fit. We thus recommend a change of the present land-use regulation in Copenhagen, which may also work as an incentive for municipalities or developer to improve the access network to the back-bone public transport network.

The socioeconomic characteristics of the travellers were also included in the models. They showed that the highest market share of public transport is found among young, low-income female travellers without driver's license. The total length of the trip is also very important for the system choice since longer total trip distances provide for a higher user utility of using public transport.

Using the results from the logistic regression models the study also suggests methodological guide lines to future methods of how to measure and define catchment area for public transport in a multimodal metropolitan area. This may guide the formulation of non-linear utility functions in mode choice models in order to capture the effect of catchments areas in a better way. The policy implication within the Copenhagen region is that the land use regulation may be change to better align the political intension of the policy promoting higher share of public transport with the actual regulations of land use.

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