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On the role of route choice modeling in transit sketchy design

Sida Luo, Yu (Marco) Nie*

Department of Civil and Environmental Engineering, Northwestern University, 2145 Sheridan Road, Evanston, IL 60208, USA

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ABSTRACT

Sketchy design models are used to examine the fundamental tradeoff in transit systems and to guide high-level decisions. Traditionally, passengers' route choice is greatly simplified in such models. This study aims to understand whether this simplification would compromise *qualitatively* the results expected from the sketchy models. To this end, three transit systems, which all offer competitive alternative routes, are analyzed using the continuous approximation approach. We test what the impact on transit system performance (e.g. optimal designs and system costs) would be if travelers somehow split between these routes, rather than concentrate on the "best" one. A random utility model is employed to enable a probabilistic assignment of passengers to different routes according to the "perceived" utility. Analytical methods are then developed to estimate the aggregate share of each route in each system, based on which the user cost is obtained. Numerical results show that, while stochastic route choice modestly increases the optimal user cost, it has a negligible effect on the agency cost. Furthermore, the actual system design is largely insensitive to route choice modeling. Thus, while the simplest deterministic route choice assumption may not be valid in all systems, transit planners can safely ignore route choice details in most cases, at least for the purpose of strategic planning.

1. Introduction

Sketchy design models are often used to examine the fundamental tradeoff in transit systems and to guide high-level decisions (e.g., Holroyd, 1967; Newell, 1973; Byrne, 1975; Newell, 1979; Ansari et al., 2017). Examples of such decisions include the choice of the underlying route structure (Nourbakhsh and Ouyang, 2012; Chen and Nie, 2017a), system-wide line density (Daganzo, 2010b; Chen and Nie, 2018), optimal fleet size (Aldaihani et al., 2004) and allocation of resources to regular and on-demand services (Chen and Nie, 2017a; Chen and Nie, 2017b; Luo and Nie, 2019). The sketchy models are often built using a continuous approximation (CA) approach, see Ibarra-Rojas et al. (2015) for a comprehensive review. While these models rarely produce designs that can be implemented directly in a city, they are instrumental to quickly exploring, assessing and refining new design concepts. In practice, they can be used for strategic transport planning.

Given their objectives, sketchy models are typically constructed with highly idealized assumptions and conditions. The question that concerns us here is whether or not these widely adopted assumptions would compromise *qualitatively* the results expected from the sketchy models. Some of these assumptions have been investigated in the literature. For example, the demand for transit services is often assumed to be homogeneously distributed within the study area. Luo and Nie (2020) show that ignoring spatial demand heterogeneity (e.g., a disproportional concentration of trips to and from a central business district) could indeed lead to sub-optimal designs, especially when the demand level is not sufficiently high. The focus of this paper is on the assumption about passengers'

* Corresponding author.
E-mail address: y-nie@northwestern.edu (Y.M. Nie).

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