



Preference heterogeneity in mode choice based on a nationwide survey with a focus on urban rail



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ABSTRACT

The provision of efficient and effective urban public transport and transport policy requires a deep understanding of the factors influencing urban travellers' choice of travel mode. The majority of existing literature reports on the results from single cities. This study presents the results of a nationwide travel survey implemented to examine multiple modes of urban passenger transport across five mainland state capitals in Australia, with a focus of urban rail. The study aims to explore differences in mode choices among surveyed travellers sampled from the five cities by accounting for two types of factors: service quality and features of public transport, and socio-demographic characteristics. A stated preference approach is adopted to elicit people's valuation of specified mode-choice related factors and their willingness to pay. In particular, the availabilities of wireless and laptop stations – two factors rarely examined in the literature, were also considered in the SP survey. The survey data were analysed using mixed logit models. To test for preference heterogeneity, socio-demographic factors were interacted with random parameters, and their influences on marginal utilities simulated. The analysis reveals that intercity differences, user group status, gender, income, and trip purposes partially explain observed preference heterogeneity.

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1. Introduction

Identifying factors and their relative importance for choosing rail transit among urban travellers is a pre-requisite for accurate forecasting of urban rail patronage and for the development of effective urban rail policy. Although there is commonly accepted guidance on forecasting rail patronage in practice (e.g., Passenger Demand Forecasting Handbook (PDFC, 2013)), our collective understanding on many factors' influence on public transit demand is inconsistent (see the next section). In addition, potential service factors such as on-board wireless access and laptop stations are rarely discussed in the literature. Moreover, the majority of the literature reports on mode choice heterogeneity within specific cities. In contrast, this paper presents the results of a unique Australia-wide study focused on identifying and quantifying the effects of service quality and demographic factors that influence urban rail patronage. This study was part of a research project funded by the Cooperative Research Centre for Rail Innovation and overseen by an advisory panel consisting of Australian rail operators and government policy advisors (Zheng et al., 2013).

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In the Australian urban rail context, recent times have seen urban rail operators confronted with unexpected increases and changing patterns of urban rail patronage. These changes have placed considerable stresses on capacities and service levels in some areas, while resulting in excess capacity in others. These stresses have presented new challenges to rail managers and have resulted in negative community feedback to state governments. Existing travel models and forecasting approaches have failed to adequately predict or explain these changes in rail patronage—for many reasons including omission of potentially important service factors in addition to well-known four step modelling technical limitations. Hence, this project was supported by rail operators as they sought to improve capabilities in understanding and forecasting urban rail trip making behaviour, to focus on urban rail and service quality factors, and to develop guidelines for the development of better forecasting and analytical models (Zheng et al., 2013).

The primary objective of this paper was to quantitatively understand how service quality and demographic factors in particular influence urban rail patronage across five Australian capital cities. Specifically, this paper (i) makes use of a nationwide comprehensive dataset for mode choices, including many important factors that may influence traveller's mode choices (ii) simultaneously tests several random parameter specifications to better explain choice heterogeneity and intercity differences in the SP data; and (iii) as one of the first studies, investigates two emerging features' impact on train usage: free Wi-Fi, and laptop stations. Note that some studies in the literature investigated providing Internet access on train and its impact on mode choice. For example, Zhang et al. (2006) focused on paid Internet access on train for business travellers. Similarly, Banerjee and Kanafani (2008) investigated Internet connection's impact on the efficiency of working on train, and studied business travellers' willingness to pay for Internet access. Obviously, these two studies are distinctively different from our study because our study focuses on free Wi-Fi access for all train passengers.

Towards this end, a large-scale, online panel survey was completed by both rail and non-rail users between April and May of 2013 in five Australian state capitals; Sydney, Melbourne, Brisbane, Perth, and Adelaide. This traveller survey focused on urban travel mode choice, including questions on people's current travel behaviours and attitudes, socio-demographics, and a stated preference experiment offering respondents choices among travel modes including car, bus, and train. The stated choice experiment was designed using experimental combinations of levels of service attributes including travel time, fare, fuel cost, parking cost, on-board crowding, and accessibility. To interpret and understand the data collected from these surveys, a set of stochastic mixed logit discrete choice models was carefully estimated.

Methodological development was not the key objective of this paper. Rather, the use of state-of-the-practice random parameters multinomial logit models (mixed logit) using a host of previously untested service quality variables combined with mode choice heterogeneity examined across five Australian cities constitutes the uniqueness of this contribution. In particular, to better understand possible unobserved heterogeneity, a host of random parameters specifications were tested, including random service quality and demographic parameters. The testing of models with many random parameters (i.e. complex dimensions of unobserved heterogeneity) has rarely been reported in the literature, mainly due to computational problems caused by the high complexity of the random parameter specifications combined with relatively low sample sizes. The relatively large sample size (i.e., over 7000 respondents with more than 42,000 stated choices) of this study enabled to the specification of several random parameters without running into computational difficulty.

The remainder of this paper first briefly introduces the context of urban rail in Australia; then reviews the literature on factors that were previously found to impact urban travel mode choice and (rail) transit ridership. Next, the survey plan, survey instrument development (focusing on the stated choice experiment), and survey administration results are described. A section describing the choice modelling results and interpretations are then presented, followed by some concluding remarks and discussion.

2. Background

Rail is a major public transport mode in many big cities. For example, rail has the largest share of passenger kilometre in the three most populous Australian cities, i.e., Sydney, Melbourne, and Brisbane (BITRE, 2009). Since 2000, several major Australian cities have experienced significant growth in passenger rail demand. For example, Melbourne's urban rail patronage growth between 2004 and 2008 was 47% (Gaymer, 2010) while Sydney's annual rail passenger journeys increased by 5.1 million between 2001 and 2006 (Brooker and Moore, 2008). Rail transport demand in large Australian cities is likely to continue to rise in the future, e.g., BITRE (2013) forecasted urban public transport demand to increase by about a third between 2010 and 2030. Similar trends of passenger rail demand were also observed in other countries, as a global rail revival is happening. In Europe, 160 cities have light rail, 65 of which was built or expanded between 1980 and 2007. In Asia, rail systems are rapidly growing in many countries, e.g., at least 14 Indian cities and 82 Chinese cities have built or are building rail systems. The growth of rail systems is also observed in the North America and Middle East (Newman et al., 2012, 2013).

Catering for increasing demand for rail services while maintaining service quality is challenging to Australian state rail authorities and planning agencies with limited funding resources. These agencies must decide how and where to invest among a variety of transport options, including urban rail. Although providing adequate capacity in an urban rail network is important, providing too much excess capacity is not desirable (unless of course demand is increasing very rapidly). Over investment in rail networks implies that funds are inefficiently allocated when they could have been directed to other projects, including other public transport modes. Thus, understanding of factors affecting passengers' rail trip decision-making process is crucial for urban mobility, service delivery, infrastructure planning, and policy formulation.

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