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Estimating recreational cyclists' preferences for bicycle routes – Evidence from Taiwan

Ching-Fu Chen [1], Pei-Chun Chen *

Department of Transportation & Communication Management Science, National Cheng Kung University, 1 University Rd., Tainan, 701, Taiwan

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ABSTRACT

This paper examines recreational cyclists' preferences for bicycle routes in Taiwan using the stated preference method. The multinomial logit model is employed to estimate the relative influences of facility attributes on bicycle route choice behaviour, while the latent class model is adopted in order to better understand the differences in preferences. Preference heterogeneity is characterized by cyclist recreation specialization level. Using data collected from 232 recreational cyclists in Taiwan, the results indicate that bicycle facility attributes, such as basic facilities and maintenance equipment, tourist information centers, and attractions exhibit significant effects on recreational cyclists' preferences. Cyclists with high levels of recreation specialization appear to be more likely to choose challenge and endurance routes than those with low recreational specialization. The implications of this work are presented and discussed.

1. Introduction

With increasing awareness of global warming and environmental protection issues, more and more people are inclined to utilize green modes of transportation. In this context, non-motorized forms of transport, such as cycling, have become more popular (Ritchie, 1998; Lumsdon, 2000). Tourism and recreational cyclists are individuals who use a bicycle for pleasure, and usually undertake short trips (Cheng & Cheng, 2003). Cycle tourism is defined as 'recreational cycling activities ranging from a day or part day casual outing to a long distance touring holiday (Lumsdon,1996). Cheng and Cheng (2004) stated that bicycle tourists and recreational cyclists have different characteristics and preferences with regard to cycle amenities. For instance, bicycle tourists are motivated mainly by a desire to enjoy attractions and engage in sightseeing, while recreational cyclists ride through areas near their homes for leisure and exercise. However, this study focuses on both recreation and tourism cyclists, using the definition of recreational cyclist presented by Ritchie (1998) as "a person involved in any recreational cycling activity or excursion, which is undertaken within a time period not longer than 24 h or one night from their home destination, and for whom cycling is seen as a positive way of using leisure time"(p.569).

The number of recreational cyclists is increasing in North America as well as in many European countries and also Taiwan. According to the Council for Economic Planning and Development of Taiwan (2009), the number of cyclists increased from 330,000 in 2006 to 700,000 in 2008; moreover, around 80% of these cycle for recreational purposes, resulting in greater demand for dedicated bicycle routes.

Previous studies on cycling behavior have mainly adopted a transportation perspective, such as examining commuting cyclists' preferences for facilities (Dill and Carr,2003; Tilahun et al., 2007), commuting route choice (Bovy and Bradley,1985; Sener et al., 2009; Stinson and Bhat, 2003), factors of bicycle usage (Hunt and Abraham, 2007), safety concerns (Allen-Munley et al., 2004), and cycle route network planning (Ortuzar et al., 2000). Relatively few studies have focused on recreational cyclists, particularly on recreational cyclists' route choices and preferences. Therefore, a better understanding of these cyclists' preferences can provide insightful information for managerial policy-making regarding recreational cycling.

Bryan (1977) suggested that diversity among participants in a particular recreational activity could be understood in terms of their degree of specialization. Cyclists with greater riding experience would thus show an increased preference for more sophisticated bicycle equipment and be more likely to travel along difficult cycle routes. Nevertheless, the concept of recreational specialization is still rarely applied when exploring cyclist preferences, and thus it is taken into account in this work.

This study focuses on recreational cyclists' preferences based on their evaluation of the service attributes of bicycle routes

* Corresponding author. Tel.: +886 6 2757575; fax: +886 6 2753882.
E-mail addresses: cfchen99@mail.ncku.edu.tw (C.-F. Chen), berylpooh@gmail.com (P.-C. Chen).
[1] Tel.: +886 6 2757575x53230; fax: +886 6 2753882.

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by means of the stated preference (SP) method, and employs logit models to estimate the relative influence of service attributes on choice behavior. The multinomial logit model (MNL) and the latent class model (LCM) approach are applied in the estimation. Compared to the MNL model for discrete choices, the LCM approach allows analysts to observe individual differences by characterizing various preference groups (Boxall and Adamowicz, 2002; Louviere et al., 2000; Greene and Hensher, 2003).

The objective of this study is to evaluate the preferences of recreational cyclists in terms of how or whether each of recreational specialization segment will affect cyclists' preferences with regard to service attributes. The empirical results should be useful for governments in developing more cycle route networks and providing better cycling facilities. The remainder of this paper is organized as follows: Section 2 reviews the previous research on bicycle route choice and the concept of recreational specialization; Section 3 describes the survey and experimental design of the study, followed by empirical results reported in Section 4. Finally, Section 5 concludes the paper.

2. Literature review

2.1. Research on bicycle route choice

Regarding the factors affecting cyclists' preferences, past studies have identified elements such as personal characteristics, the environment, and bicycle facilities (Sener et al., 2009; Stinson and Bhat, 2003; Tilahun et al., 2007). Research has shown that cyclists have different preferences with regard to bicycle facilities depending on their purpose (Antonakos, 1994; Sener et al., 2009). Moreover, based on trip purpose, bicycle route choice studies can be classified into two types: commuting and recreational, with Sener et al. (2009) revealing those commuting and recreational cyclists have different preferences. For instance, commuter cyclists prefer bicycle routes with no parking and lower traffic volume, while recreational ones prefer bicycle routes with moderate and steep hills.

As for the factors affecting recreational cyclists' bicycle route choice, besides basic bicycle facilities, important elements include the level of cycling experience, bicycle lane type, roadway grade, and scenery (Antonakos, 1994; Sener et al., 2009). Chang and Chang (2009) explored recreational cyclists' environmental preferences in Taiwan, and the results indicated that the most favored item for recreational cyclists was bicycle paths separate from the main road. Downward and Lumsdon (2001) evaluated the factors considered important by recreational cyclists when choosing recreational cycle routes,and their findings highlighted the importance of quiet roads and traffic-free routes. Furthermore, intangible attributes also appear to be very significant, such as good scenery. In addition, other research has shown that with increased age and experience, recreational cyclists express preferences for bicycle lanes and wide curb lanes instead of bicycle paths and trails (Antonakos, 1994).

2.2. Recreation specialization

Bryan (1977) first proposed the conceptual framework of recreation specialization to describe trout anglers in Idaho, Montana, and Wyoming. In his work, recreational specialization is defined as "a continuum of behaviour from the general to the particular specialization, reflected by equipment and skill used in the sport and activity setting preferences" (p.175). Bryan's initial work emphasized the behavioral and cognitive aspects of specialization, with indicators such as equipment and skill. Subsequently, McIntyre (1989) argued that using single or even two-dimensional (behavioral and cognitive) approaches to recreational specialization would result in inconsistencies and limitations in the results. Therefore, McIntyre and Pigram (1992) proposed a multi-dimensional approach to recreational specialization, considering behavioral (e.g., experience), cognitive (e.g., level of skill), and affective dimensions (e.g., enduring involvement), with these components being interrelated and mutually reinforcing. Other researchers have used a multidimensional construct to measure the level of recreational specialization (Bricker and Kerstetter, 2000; Lee and Scott, 2004; McFarlane, 2004; Oh and Ditton, 2006; Scott and Shafer, 2001). However, there is a lack of research relating differences in cyclists' preference to their level of recreational specialization using the stated preference method and choice models. In this study, recreational specialization is used to measure cyclists' degree of specialization and capture cyclists' preferences for routes.

3. Method

3.1. Model specification

Random utility theory is the theoretical basis of discrete choice models (McFadden, 1974) and is used in this research. This theory starts from the assumption that individuals generate their market behavior by maximizing the utility of their preferences, and it is used in this study to explain individual choices by specifying functions for the utility derived from the available alternatives. The utility function is estimated using a multinomial logit (MNL) model based on the premise that choices are consistent with an independence from the irrelevant alternatives (IIA) property. IIA indicates that the ratio of choice probabilities for any two alternatives for any individual is entirely unaffected by the systematic utilities of either of the alternatives. Assuming utility-maximizing behavior by the decision maker, the indirect utility function U_{ij} for each individual i who chooses alternative j in the choice set Ci can be expressed as:

$$U_{ij} = V_{ij}(X_{ij},Z_i) + \varepsilon_{ij} = \beta X + \delta Z + \varepsilon_{ij} \quad (1)$$

The utility function U_{ij} can be decomposed into the determinant part V_{ij}, which is typically specified as a function of deterministic components, including a vector of service attributes (X) and individual characteristics (Z). In addition, the error term ε_{ij}, which represents the unobservable individual characteristics, can influence choices (Louviere, et al., 2000). Furthermore, in this study, β represents a vector of coefficients estimated for individual preferences on service attributes, and δ represents a vector of coefficients estimated for individual characteristics.

The dependent variable of Eq. (1) represents individual choice behavior and is a discrete variable. If $U_{ij} > U_{ik}$ for all $j \neq k$ in the choice set C_i, then the probability that individual i will select alternative j over k is given by:

$$P(j|C_i) = P(V_{ij} + \varepsilon_{ij} > V_{ik} + \varepsilon_{ik}) = P(V_{ij} - V_{ik} > \varepsilon_{ik} - \varepsilon_{ij}) \quad (2)$$

This probability depends on the hypotheses formulated about the distribution of the random vector of error terms. If the error term ε_{ij} is independently and identically distributed (IID), Gumbell distributions will occur across the population (Ben-Akiva and Lerman, 1985), and thus a standard logit model, or multinomial logit model (MNL), is applicable. With the MNL model, the probability $P(j|C_i)$ can be expressed as:

$$P_{ij} = \frac{\exp(V_{ij})}{\sum_{k \in C_i} \exp(V_{ik})} \quad (3)$$

The latent class model (LCM) approach is also applied in the estimation. The LCM assumes that the population consists of