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Who cycles more? Determining cycling frequency through a segmentation approach in Montreal, Canada

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ABSTRACT

The decision to cycle frequently in an urban setting is a complex process and is affected by a variety of factors. This study analyzed the various factors influencing cycling frequency among 1707 cyclists from Montreal, Canada using an ordinal logistic regression. A segmentation of cyclists is used in a series of ordinal logistic models to better understand the different impacts of variables on the frequency of cycling among each group of cyclists for commute and for utilitarian purposes. Our models show a variation in the impacts of each dependent variable on frequency of cycling across the various segments of cyclists. Mainly making cyclists feel safe not only on bicycle specific infrastructure but also on regular streets, emphasizing the low cost, convenience and improving the opinion on cycling in the population are effective interventions to increase bicycle usage. Also, it was shown that women were less likely to cycle to work than men, but more likely to cycle for other utilitarian trips, pointing at the presence of specific barriers to commuting for woman. Although the findings from this study are specific to Montreal, they can be of interest to transportation planners and engineers working toward increasing cycling frequency in other regions.

1. Introduction

Policy makers and officials promoting cycling often use health, congestion reduction and environmental benefits as a way to convince people to cycle more. While these benefits make an increase in cycling a logical goal for decision makers, they might not be the most effective argument in a promotional campaign or a good guide for planning interventions aimed at increasing bicycle usage. Focusing on the convenience and flexibility of cycling might be a better strategy to increase cycling for utilitarian purposes (Pucher and Buehler, 2008). Indeed, Börjesson and Eliasson (2012) found that it is better to present cycling as a mode that can compete with others rather than focusing on environmental and health benefits.

There is a vast amount of literature on cycling usage and frequency determinants, but ambiguity remains and conclusions have been inconsistent for many variables (Heinen et al., 2010). For example, several studies found that men cycle more frequently than women (Dill and Voros, 2007; Stinson and Bhat, 2004), while some studies suggest otherwise (de Geus et al., 2008; Wardman et al., 2007). Many other variables did not bring consensus, like age, built environment and income. This study builds on past findings to test the importance of the determinants of cycling frequency. It furthermore uses a novel

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segmentation approach and adds new variables that have not been tested before in previous research. Population segmentation has been shown to nuance results and to be useful in informing decision makers about interventions (Dill and McNeil, 2013; Geller, 2006; Kroesen and Handy, 2013). Indeed, different types of cyclists react differently to different types of infrastructure (Larsen and El-Geneidy, 2011) or to varying conditions (Bergström and Magnusson, 2003; Nankervis, 1999). This study uses a sample of 1707 Montreal cyclists and a segmentation analysis that has been developed in a previous study (Damant-Sirois et al., 2014) to understand the determinants of increasing cycling frequencies among specific types of cyclists for different purposes.

The findings of this research can help transportation planners, engineers and policy makers design and effectively adopt interventions or promotional campaigns that can increase bicycle usage in cities. In the following sections we present the relevant literature on determinants of bicycle usage and frequency, and on cyclists' typologies. This is followed by an explanation of the study context and data used. Later we present the methodology, which is followed by a presentation of the analysis and results. The paper ends with a discussion of the results, conclusions and policy recommendations.

2. Background

2.1. Determinants of cycling

Determinants of cycling can be grouped into four main categories: individual characteristics (e.g. gender, household size), individual attitudes, social environment (e.g. mode of transportation norms, social perception of cyclists), and built environment.

2.1.1. Individual characteristics

While some studies found that age has no clear impact on cycling (Kitamura et al., 1997; Wardman et al., 2007), most studies observed a variation in cycling usage with age (Dill and Voros, 2007; O'Connor and Brown, 2010). With regard to gender, when drawing a general portrait of the cyclist population, the share of women cycling compared to men has been shown to be smaller. Therefore, sex has been explored as a determinant of bicycle usage and their relationship has been shown to be significant (Akar et al., 2013; Landis et al., 1997; Levinson et al., 2005) and is often explained by claiming that women are more risk averse than men or that women could still be more involved in household responsibilities (Garrard, 2003; Heinen et al., 2010). The structure of a cyclist's household has shown to be significantly correlated with bicycle usage (e.g. number of people in household) (Moudon et al., 2005; Ryley, 2006) as is car ownership (Dill and Voros, 2007; Kitamura et al., 1997; Parkin et al., 2008; Stinson and Bhat, 2004).

2.1.2. Individual attitudes

Fernández-Heredia et al. (2014) show that attitudes can directly influence the intention of cycling, but also the perception of the benefits and barriers of cycling. Pro-bicycle attitudes and pro-car attitudes have both strong and opposite impacts on cycling frequency and behavior (Dill and Carr, 2003; Fernández-Heredia et al., 2014; Handy and Xing, 2010; Heinen et al., 2011, 2013; Vredin Johansson et al., 2006). Safety perceptions, which are considered to be one of the most important determinants of cycling (Heinen et al., 2011; Rietveld and Daniel, 2004; Titze et al., 2007; Xing et al., 2010) are also impacted by individuals' attitudes (Fernández-Heredia et al., 2014). Having a pro-environment attitude has also been shown to be positively correlated to frequent cycling (Li et al., 2013; Vredin Johansson et al., 2006). Finally, Fernández-Heredia et al.(2014) show that people who see cycling as a way to exercise are more likely to cycle more often.

2.1.3. Social environment

A review of the literature on cycling determinants showed that many studies have found a significant correlation between cycling frequency and different social environment variables (Willis et al., 2015). Xing et al. (2008) found that one's social environment was a stronger determinant of bicycle ownership and usage than the built environment. It has a strong impact on the decision to use a bicycle for recreational purposes (Xing et al., 2010). Titze et al. (2007) and Heinen et al. (2013) found that social and peer support for cycling have a strong and positive impact on the decision to commute by bicycle. A study by de Geus et al. (2008) had a similar conclusion and showed that augmenting social support through a campaign would be an efficient way to increasing cycling frequency.

2.1.4. Built environment

This category has been extensively studied and while earlier research found a strong and positive correlation with bicycle usage (Cervero and Kockelman, 1997; Dill and Carr, 2003), results have been nuanced with the introduction of self-selection as a control variable (Handy et al., 2005). Self-selection represents the idea that people who already have the intention of cycling will locate themselves in areas that offers substantial bicycle infrastructure. This gives the impression that this type of infrastructure incentivizes people to cycle more. However, even when controlling for self-selection and individual attitudes, some studies still found some correlation between cycling usage and the built environment (Pinjari et al., 2009; Xing et al., 2010). Some studies also show that infrastructure has an impact on individuals' perceptions of safety while cycling (Carver et al., 2010; Fraser and Lock, 2011). Others have demonstrated that infrastructure influences the behavior