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The stops made by commuters: evidence from the 2009 US National Household Travel Survey

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ABSTRACT

Trip chaining, especially during peak-hour commute trips, is an important aspect of travel behavior that impacts the private and social costs and benefits of urban passenger travel. Combining large-sample data from the 2009 National Household Travel Survey (NHTS) and the 2010 US Census, this study analyzes the relationship between the complexity of commute tours and the characteristics of not just commuters and their households, but also their neighborhoods and regions. Different from most existing studies, this analysis controls more detailed individual, household, employment, and location characteristics and important interactions. In particular, by linking the restricted-use location data of households and work places from the NHTS survey to the US Census data, this study quantifies the effects of job-end population and employment densities. Results confirm the important impact of socio-demographics (gender, household responsibilities, and flexible work schedule), which underwent significant changes in the recent past, but fail to identify strong effects of socio-economic status, the regional and local built environment, or gasoline price.

1. Introduction

Many non-work related trips happen during weekday peak hours, including taking children to school or running errands before and after work (e.g., Davidson, 1991). Between 1977 and 1983, non-work trips grew faster than commute trips, especially during peak periods (Gordon et al., 1988). In 1983, weekday non-work trips made up about half of all morning peak-hour trips and slightly over two-thirds of all evening peak-hour trips (Downs, 1992). Evidence has also shown that non-work trips had increasingly been connected by short stops into commute travel, even as congestion levels had been generally increasing across urban regions. Between 1995 and 2001, there was a 21% increase in the number of commuters who trip chained in the home-to-work direction and a 12% increase in commuters who trip chained in both directions (US DOT, 2001). The reason for such increases amid the rise in congestion levels has been linked to trip cost savings (Gordon et al., 1988) and demographic changes such as the rise in single-adult and dual-income households, especially those with young children (Strathman et al., 1993; Strathman and Dueker, 1995).

Studying the important phenomenon of trip chaining is necessary to understand its potential positive and negative effects. Given the high share of family and personal business trips in passenger travel, by chaining otherwise separate trips, travelers may decrease the total amount of travel required to conduct activities and reduce the overall vehicle-miles traveled (VMT).[1] However, if commuters integrate non-work trips into commute travel that would otherwise happen during off-peak hours, there could be heavier peak-hour congestion and increased total costs. Understanding the mechanism and consequences of trip chaining among commuters has important policy significance.

Studying why and how travelers organize non-work trips around their daily commute (thus forming "tours") is also important for advancing our understanding of the linkage between activity and mobility, a crucial but challenging goal of the emerging activity-based travel models (e.g., Kitamura, 1988; Jones et al., 1990).[2] As pointed out by TRB (2007), due to analytical complexity and the often prohibitive data demand, tour-, or activity-based models have only been applied by a small number of US transportation planning agencies.

This study focuses on US commuters' trip chaining behavior, most of which happens during the peak hours, controlling for built environmental variables at the community and metropolitan

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[1] See http://www.nj.gov/dep/baqp/docs/triptraining_fs.pdf.

[2] Compared to the dominant four-step trip-based approach, it is widely recognized that an activity-based travel model provides a conceptually stronger framework for analyzing complex and interconnected travel patterns (e.g., trip-chaining behavior and intra-household interactions) and enables better understanding of travelers' responses to transportation policies (TRB, 2007).

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levels. Applying the negative binomial regression model to tour-based travel data, this study comprehensively explores the relationship between the complexity of commute tours and the characteristics of commuters, households, and their neighborhoods and regions. The combined use of two large datasets, the 2009 National Household Travel Survey and the 2010 US Census enables a test of the effects of population and job densities at not only the home-end, but also the job-end of commute trips. The rest of the paper presents a summary of existing literature, a description of the data and research method, the study results with a summary of the findings in light of literature, and a conclusion.

2. Literature review

The understanding of passenger trip chaining is closely related to that of the interconnection between travel, activities, and time allocation, a focus of transportation behavior research since the early 1970s. In their seminal work on trip chaining in non-work travel, Adler and Ben-Akiva (1979) explain the demand for trip chaining as the result of household utility maximization by balancing the need to fulfill different activities across space and time with the required travel expenditures. They consider "scheduling convenience," travel time and cost, attributes of chosen destinations, and the socioeconomic characteristics of a given household as the major factors influencing household travel patterns. Kondo and Kitamura (1987) provide an alternative perspective on chaining non-work activities in commute trips. Showing empirical evidence of non-diminishing marginal benefits of in-home time, they argue that longer non-work activity duration, longer home-activity and home-work distances, and slower travel speed will not favor a multi-stop trip chain.

Empirical work on trip chaining has long focused on the analyses of factors associated with trip chaining behavior. Evidence provides a rich picture of the household-activity-mobility linkage, showing a wide array of factors affecting trip chaining, such as the demographic and socio-economic attributes of the primary traveler and the household, characteristics of trips being made, and land-use patterns.

Within households, women are found to chain other trips into their commute more often than men (Bhat, 1997; Hamed and Mannering, 1993; Strathman and Dueker, 1995). In particular, women are more likely to escort children to/from school in two-worker families (McGuckin and Nakamoto, 2005). In a broader framework of household structure-travel linkage, Oster (1979) finds that when reduction in household size is coupled with an expansion of multiple-worker households, the tendency to link non-work trips to the work commute increases. Using a Dutch travel survey, Golob (1986) examines the relationship between travelers' individual and household characteristics and home-based trip chaining. He finds that household lifecycle (i.e., household composition and working status) is the most effective explanatory variable, followed by age, income, and the gender of workers. Strathman et al. (1993) find that certain household types contributed the largest amounts of peak-period trip chaining behavior: single adults, dual-income couples, dual-income families with preschoolers, and multi-worker households. Modeling the interrelationship among socio-demographics, activity participation, and travel behavior with structural equations, Lu and Pas (1999) find that having more children in the household generates more chains, employed people make fewer chains than people who are not employed, and more workers in the household results in fewer chains. Similarly, Wen and Koppelman (2000) find that the number of stops made for household maintenance purpose is proportional to household size and the number of children in a household, with an unemployed person (or part-time employee) more likely assigned maintenance stops than an employed person.

The literature has also examined the connection between travelers' income level, car ownership (or having a driver's license), and travel mode and their trip chaining behavior, but findings are inconsistent. Golob (1986) shows that car ownership and residential location are the least influential variables on home-based trip chains in the Netherlands, probably due to the high transit level of service and extensive use of the bicycle. Applying a recursive model system for trip generation and trip chaining to a Dutch travel survey, Goulias and Kitamura (1991) find that higher-income households tend to consolidate trips into multi-stop chains, but vehicle ownership does not affect trip chaining after trips are generated. More recently, Lu and Pas (1999) find that people who have a license make more trip chains, while Wen and Koppelman (2000) show that the number of household maintenance stops made is proportional to household income and the number of cars owned. In the US, travel mode is closely related to income and car ownership. Studies often suggest that transit trips have fewer stops and types of activities within a tour than tours made by other modes (e.g., Frank et al., 2008; Horowitz, 1982; McGuckin et al., 2005; Wallace et al., 2000). However, Bernardin et al. (2011) find that low household income and lack of vehicle ownership correspond to complex multi-stop, multipurpose transit work tours, while more affluent transit commuters, probably over-sampled in many travel surveys, made much simpler tours.

Last but not least, land use patterns may affect trip chaining, although the findings are inconclusive. Williams (1988) considers household activity, trip frequency, and travel time in concert with accessibility indices to show that ceteris paribus, residents in less accessible areas are more likely to form trip chains and have higher trip frequencies. Using data from Seattle, Washington, Wallace et al. (2000) find that accounting for household characteristics, tours based in urban centers include fewer trip links, while those living outside urban centers are more likely to plan complex tours. Similarly, using the 2001 NHTS data, Noland and Thomas (2007) show that lower residential population density leads to both a greater reliance upon trip chaining and to tours that involve more stops along the way, controlling for key household and traveler characteristics. Different from the above findings, Krizek (2003) observes that households moving from low to medium density neighborhoods make shorter tours following their relocation, but show no difference in the complexity of their tours. Moreover, applying a household trip generation model that jointly forecasts activity participation, trip chaining, and travel time to data from the Portland metropolitan region, Golob (2000) finds that network- and especially zone-level accessibility indices are positively related to the participation in out-of-home non-work activities and home-based non-work trip chains.

Although the existing evidence about trip chaining has confirmed some hypotheses about activity or travel demand (e.g., factors related to household characteristics), inconsistent and even conflicting findings remain, particularly with regard to land use and/or accessibility, which affect the cost of travel. In the meantime, much of the empirical evidence is drawn from relatively small samples and a limited spatial scope. More regional and national studies and more evidence on the effects of land use can benefit our understanding of trip chaining and the development of better travel models. This study represents an effort to address these gaps in literature to further explore the factors influencing the trip chaining behavior of commuters.

3. Data

The NHTS survey is the only national level dataset regarding trip chaining in the US. This study combines both the publicly available data and restricted-use data (in California) from the latest

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